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ABSTRACT

"Advances in Education Research" reprints previously published journal articles reporting on research supported in whole or in part by the Office of Educational Research and Improvement (OERI). The articles are selected from peer-reviewed/referred journals; the journals used are described briefy at the end of the volume. The articles in this volume are all concerned with reading comprehension and subject-area learning: (1) "The Contribution of Prior Knowledge and Coherent Text to Comprehension" (Margaret G. McKeown, Isabel L. Beck, Gale M. Sinatra, and Jane A. Loxterman); (2) "Inclass or Pullout: Effects of Setting on the Remedial Reading Program" (Rita M. Bean, William W. Cooley, R. Tony Eichelberger, Meryl K. Lazar, and Naomi Zigmond); (3) "Individual Differences in Reprocessing of Text" (Dieter Haenggi and Charles A. Perfetti); (4) "The Process of Understanding: Reading for Literary and Informative Purposes" (Judith A. Langer); (5) "What Influences Learning? A Content Analysis of Review Literature" (Margaret C. Wang, Geneva D. Haertel, and Herbert J. Walberg); (6) "Revising Social Studies Text from a Text-Processing Perspective: Evidence of Improved Comprehensibility" (Isabel L. Beck, Margaret G. McKeown, Gale M. Sinatra, and Jane A Loxterman); and (7) "Sense Making and the Solution of Division Problems Involving Remainders: An Examination of Middle School Students' Solution Processes and Their Interpretations of Solutions" (Edward A. Silver, Lora J. Shapiro, and Adam Deutsch). Each article contains references. (SLD)

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Advances in Education Research

Volume 2, Spring 1997

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Advances in Education Research

Volume 2, Spring 1997

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This second volume of *Advances in Education Research* includes previously published articles from selected refereed journals, which are briefly described at the end of this volume. The articles are reproduced with the permission of the authors and the journals in which they originally appeared. They were written by individuals who received funding through OERI's Field-Initiated Studies program for conducting research on how children learn to read and how they learn various academic subjects.

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Introduction

As the federal government's main resource center for education information, the National Library of Education (NLE) provides three types of services—reference and referral, collection and technical, and resource sharing. In addition to housing microfiche catalogs and CD-ROM databases, NLE maintains a vast collection of printed resources, including more than 200,000 books and nearly 800 periodical subscriptions. NLE also offers specialized subject searches, electronic database search and retrieval, document delivery, bibliographic instruction, training services, interlibrary loans, legislative reference services, and selective information dissemination.

In its role it as the nation's collector and creator of education research information, NLE produces publications such as *Advances in Education Research* to promote recent research findings and disseminate the latest education information. This issue of *Advances in Education Research* presents seven articles that cover two themes: reading comprehension and subject-area learning. The articles unify these two themes under a central focus—the processes through which students understand, interpret, and use information. To investigate these processes, the researchers use a variety of approaches, including direct observation, case study analysis, experimental intervention, and research synthesis. Regardless of the methods or the objectives of the individual studies, the researchers work toward a common goal—improving students' abilities to process and use information.

Reading Comprehension

Because reading comprehension is a complex process, it has many unique aspects that can be studied from numerous perspectives. Interested in the aspect of influences on comprehension, McKeown, Beck, Sinatra, and Loxterman (*The Contribution of Prior Knowledge and Coherent Text to Comprehension*) explore how background knowledge and text coherence affect reading comprehension. McKeown et al. begin their study with the premise that coherent text clearly improves reading comprehension, and they expand on this idea by examining the influences that background knowledge has on comprehension.

For their study, McKeown et al. separate 48 fifth-grade social studies students into two groups—those who read an original text and those who read a revised version of that text. Before reading the texts, the students are taught a knowledge module that provides background information not presented in the texts. After reading the texts, the students are questioned to determine the level of their comprehension.

The initial findings of the study only corroborate conclusions of other studies that show a clear correlation between coherent text and improved reading comprehension. To extrapolate additional meaning from their findings, McKeown et al. compare these findings with results from an earlier study that focused only on the influence of coherent text. (They justify comparing both sets of data because the same experimenter gathered the data from the same school using the same curriculum and the same fifth-grade social studies teacher. The only difference is that in the earlier study, the students did not receive the background information.)

After comparing the data from both studies, McKeown et al. discover that the inclusion of background knowledge is "not an overall general effect" and that text coherence "seems to be the stronger enhancement for understanding complex content." Despite this conclusion, the combination of background knowledge and coherent text appear to provide "an advantage beyond the sum of what the two provide separately."

During the course of their study, McKeown et al. unintentionally experience another phenomenon associated with background knowledge. This phenomenon occurs when background knowledge overrides text information "in such a way that readers recall text or respond to questions with information from their knowledge base, even though it is not supported by—and in some cases is even contradictory to—the text." Although this phenomenon is prominent in current literature, it requires further exploration.

Studying a different aspect of reading comprehension, Bean, Cooley, Eichelberger, Lazar, and Zigmond (*Inclass or Pullout: Effects of Setting on the Remedial Reading Program*) examine how classroom settings affect Chapter I remedial reading programs, focusing on the pullout and inclass models. In the pullout model, students leave their regular classroom setting to receive instruction from a reading specialist, while in the inclass model, the reading specialist enters the regular classroom to determine student needs and work with specific students.

Using data from a larger study, Bean et al. are mainly concerned with the nature of each type of remedial reading program and with differences in instructional behaviors, lessons, and reading behaviors. To help control for reading philosophy, materials, community characteristics, and teacher quality, they gather data from a school district containing several schools that implement each type of program. Relying on classroom observations, Bean et al. analyze how time is allocated in each program, concentrating on how reading specialists teach, how students behave, what lessons are taught, and what activities are completed.

Their findings uncover a complex combination of similarities and differences that "seem to have an effect on the nature of the instruction experienced by students." Among the similarities, students in both programs receive instruction as members of a group, they spend minimal time pursuing independent activities such as workbook or worksheet assignments, and they spend most of their time listening. Among the differences, pullout programs focus mainly on skill instruction while inclass programs emphasize study skills or testing activities, and students in pullout programs spend less time in transition while those in inclass programs have more time without interaction or scheduled instruction.

Although Bean et al. conclude that "setting can make a difference in terms of what students experience in compensatory education," they admit that changing settings cannot adequately integrate students into regular education programs because switching from a pullout to an inclass program "appears to be much more complex and perhaps less effective than one would hope." For this reason, they suggest that additional research must be completed to determine the effectiveness of integration and alternative models for compensatory programs.

Concentrating on a more specific area of reading comprehension, Haenggi and Perfetti (*Individual Differences in Reprocessing of Text*) examine how basic reading processes and prior knowledge affect text reprocessing. Haenggi and Perfetti begin their study by separating a class of 48 undergraduate students into two groups according to reading ability—average and above-average readers—and further subdividing each group according to three reprocessing conditions—rewriting notes, rereading notes, and rereading text. After establishing these groups, they test the students' comprehension of three types of information—explicit, text-implicit, and script-implicit—and use these information types to determine the influence of working memory and prior knowledge.

Because of the numerous variables explored in their study, Haenggi and Perfetti are able to make several conclusions. Most notably, they determine that reprocessing text generally improves reading comprehension, regardless of the reprocessing condition, and that "individual differences in basic reading processes and prior knowledge contributed more to reading comprehension than did the specific reprocessing activity." Using additional findings, they conclude that reprocessing affects average and above-average readers differently.

Despite Haenggi and Perfetti's exploration of multiple variables, several hypotheses remain untested. For example, less-skilled readers may find rereading notes more helpful in improving their comprehension than other strategies, while skilled readers are less affected by reprocessing strategies. Also, the availability of retrieval cues may "be the reason for the weak relation between the number of noted idea units and comprehension accuracy after a first learning trial ... as well as after reprocessing."

Interested in the aspect of meaning making, the process readers use to develop an understanding of what they read, Langer (*The Process of Understanding: Reading for Literary and Informative Purposes*) examines how middle and high school students create meanings as they read literary and informative texts. Focusing on literary meaning making, Langer explores how students understand literature and how the development of this understanding relates to informative reading selections such as science and social studies.

Using think-aloud sessions to analyze the meaning-making process, Langer determines that reading "involves a variety of changing stances that the reader takes toward the text." These stances are recursive, and readers experience them while reading either literary or informative texts. The four stances Langer defines are (1) being out and stepping into an envisionment, (2) being in and moving through an envisionment,

(3) stepping back and rethinking what is known, and (4) stepping out and objectifying the experience.

Langer also discovers that in addition to experiencing local envisionments of the text, readers assume different orientations in literary and informative contexts. In the literary context, readers' sense of the whole continually changes and develops "as a constantly moving *horizon of possibilities*." In the informative context, the sense of the whole remains static as "a steady *point of reference*." These two orientations ultimately influence the readers' concerns within each of the four stances and their approach to the meaning-making process.

Although Langer's research focuses on middle and high school students, the results have several broad applications. The concept of stances that reflect readers' growing envisionments can offer "an alternative to existing category systems that are primarily based on *types* or *levels* of response." Furthermore, because these stances are linked to extending the understanding of texts, they can be used "to analyze the extent to which readers are or are not willing or able to extend their envisionments in order to reach a fuller response."

Subject-Area Learning

Numerous variables influence students' ability to learn any subject matter. Interested in those variables, Wang, Haertel, and Walberg (*What Influences Learning? A Content Analysis of Review Literature*) analyze 179 sources, including handbook chapters, annual review chapters, government documents, commissioned papers, book chapters, and journal review articles. Using these sources, they conduct a research synthesis to identify the variables that have the strongest influence on learning.

Before beginning their research synthesis, Wang et al. identify 228 comprehensive variables that influence learning outcomes and organize those items into a conceptual framework based on the major theoretical models of school learning. This conceptual framework separates the variables into 6 categories that encompass 30 a priori scales. Wang et al. rate the 228 variables appearing in the source documents, using a detailed 15-page coding form. After rating the variables, they analyze the coding forms "to determine the emergent consensus on which items exert the most powerful influence on learning outcomes."

This research synthesis confirms that quantity and quality of instruction, home environment, and student characteristics are most important to learning outcomes because these items are "directly tied to students' engagement with the materials to be learned." Of the 30 a priori scales, the items having the strongest influence on learning are student metacognition, effective classroom management, quantity of instruction, positive and productive student-teacher interactions, a classroom climate conducive to learning, and a peer culture supportive of academic achievement.

Introduction

Wang et al. note that many authors of research studies and reviews are often cautious when determining the influence that individual variables have over learning. However, this caution is very appropriate because this research synthesis confirms "that a large number of variables are moderately related to learning outcomes, but few, if any, single variables are strongly related to learning."

Concerned with the quality of instruction, Beck, McKeown, Sinatra, and Loxterman (*Revising Social Studies Text from a Text-Processing Perspective: Evidence of Improved Comprehensibility*) examine how improving the quality of textbooks can improve learning. Beginning with the premise that incomprehensible text inhibits the ability of readers to learn, Beck et al. revise passages from a fifth-grade social studies textbook so that the text relates information clearly. In addition to presenting the rewritten passages, they explain their rationale for the revisions to illustrate one process that can be used to revise textbooks.

The goal of the revisions is "to create a text that would assist a reader in connecting pieces of text information and combining that information with knowledge to develop a coherent text representation." By revising text to activate relevant schema, add explicit signals, and remove extraneous information, Beck et al. ensure that causes are connected to events and that events are connected to consequences. After making appropriate revisions, they test fourth- and fifth-grade students to determine how revisions influence learning.

The findings of their study clearly show that revising text for clarity improves students' ability to comprehend and recall information. Furthermore, because the passages are revised to reveal cause-and-effect relationships among events, students are able "to explain the actions of the text and to move the chain of events forward."

Although their study demonstrates the need for quality textbooks, Beck et al. note two weaknesses to revising texts. First, simple revisions to text do not adequately explain complex issues because "even a coherent, well-designed text is unlikely to communicate to a young learner all the information that a mature reader could glean from it." Second, "creating comprehensible text is a very complex task, and its complexity precludes devising a set of formulaic procedures." Because of these weaknesses, they hope that the models accompanying their study "can serve as mechanisms for transferring knowledge to new instances."

Interested in students' interpretations of numerical answers obtained from story problems, Silver, Shapiro, and Deutsch (*Sense Making and the Solution of Division Problems Involving Remainders: An Examination of Middle School Students' Solution Processes and Their Interpretations of Solutions*) explore how mathematics students handle augmented-quotient division-with-remainder problems. Testing referential mapping models proposed in earlier research, Silver et al. examine students' solution processes and their situation-based reasoning as they solve story problems.

Introduction

To investigate these solution processes and the associated reasoning, Silver et al. give students a free-response pencil-and-paper task that requires students to calculate a numerical figure using a mathematic procedure and interpret that figure for the solution to the story problem. In addition to providing the solution, students must explain the logic that they used to determine their answers.

After analyzing their data, Silver et al. conclude that "computational requirements were not the major barrier to obtaining a correct solution but rather that unsuccessful solutions were more often due to students' failure to engage in interpreting their computational results." In another finding, they conclude that many students are more concerned about the form of their computations and final answers than "about the relationship between the numerical answer and the problem being solved." Furthermore, anecdotal evidence suggests that the written explanations of the solution reveal only a portion of the students' situation-based reasoning.

Because of these findings, Silver et al. believe that further research and improved instruction are necessary. In addition to promoting the investigation of the relationship between problem-solving procedures and situational contexts, they suggest examining "alternative assessment settings or formats that might target more directly the need for sense making and solution interpretation." Finally, they recommend "developing and implementing instructional activities in which children are challenged to engage in mathematics sense making" to improve "the poor mathematics performance of American students."

In addition to providing a better understanding of the processes through which students understand, interpret, and use information, the seven articles contained in this issue present ideas and suggestions that can help improve students' abilities to process and use information. These articles demonstrate the complex nature of learning, illustrating the importance of current research while presenting possibilities and directions for future research. The ultimate value of these articles is that they highlight the role of research in improving learning and the entire educational system.

(1992). Reading Research Quarterly, 27, 79-93.

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The contribution of prior knowledge and coherent text to comprehension

Learning, both in school and beyond, is heavily dependent on acquiring information from text. Research on text processing over the last two decades has greatly expanded understanding of what is involved in reading and learning from text. The current view of reading has shifted from that of a simple process of lifting the message from a text to that of an active, complex process in which a reader draws on information from several sources concurrently to construct a representation of a text's message.

The constructivist orientation of recent research has highlighted the role of a reader's background knowledge. Research has emphasized that not only does lack of knowledge about a topic impede comprehension, but the extent of knowledge influences the quality of understanding that a reader can construct. Research by Voss and his colleagues (Chiesi, Spilich, & Voss, 1979; Means & Voss, 1985; Spilich, Vesonder, Chiesi, & Voss, 1979) and Chi and her colleagues (Chi, 1978; Chi, Feltovich, & Glaser, 1981; Chi, Glaser, & Reese, 1982; Chi & Koeske, 1983) has shown the advantage in comprehension for high knowledge versus low knowledge individuals.

Another influence on a reader's ability to acquire information from text is the way the text content is organized and explained. The concept of coherence has been used to describe the kind of organization of text that facilitates the reader's task. Thus, coherence is the extent to which the sequencing of ideas in a text makes sense and the extent to which the language used to present those ideas makes the nature of the ideas and their relationships apparent.

Research on text has provided evidence of the relationship between coherence and the comprehensibility of a text. Studies that present readers with more and less coherent versions of text have shown that the more coherent versions yield better comprehension (Beck, McKeown, Omanson, & Pople, 1984; Beck, McKeown, Sinatra, & Loxterman, 1991; Britton, 1990). The concept of coherence and its role in text comprehensibility is also an aspect of Anderson and Armbruster's (1984) notion of "considerate text."

Research context for studying the contribution of knowledge and coherent text

Advances in understanding the complexity of the reading process, particularly the role of the reader's knowledge and the characteristics of text that influence comprehension, provide a rich context for investigating instructional issues. We have used this context as the base for a program of research on learning history from social studies textbooks. This research effort started with an analysis of textbooks (Beck, McKeown, & Gromoll, 1989), followed by an investigation of students' prior knowledge (McKeown & Beck, 1990), and then a study of the effects of more and less coherent texts on students' comprehension (Beck et al., 1991). The present study, which looks at the effect of background knowledge on more and less coherent texts, represents a culmination of this program of research.

Analysis of textbooks. Beck et al. (1989), in an analysis of content and content presentation in four widely used social studies programs, concluded that the presentation of history in the programs examined was not oriented toward helping young learners develop a coherent representation of various historical topics and periods. At a general level, there seemed to be two related reasons why this was so. First, the texts assumed an unrealistic variety and depth of prior knowledge from target-age students. Second, the presentation of content was less than coherent. That is, the texts tended to present numerous facts, but there was little explanation of relationships among facts. Such texts require young learners to make many connecting inferences among events and ideas with little, if any, assistance.

Both issues—the unrealistic assumption of prior knowledge and the influence of textual coherence—were empirically examined in subsequent studies (Beck et al., 1991; McKeown & Beck, 1990). In both studies the topic selected for investigation was the period leading to the American Revolution, which traditionally is first encountered formally in the fifth-grade curriculum. This topic was selected for study because of its importance. That is, because the period embodies the principles upon which the U.S. is founded, its influence is enormous for young Americans' subsequent learning in history, as well as other subject matters, and is strongly reflected in diverse aspects of American culture.

Investigation of prior knowledge. The McKeown and Beck (1990) study examined fifth graders' knowledge of the Revolutionary period to evaluate whether students had acquired the knowledge that was assumed by the text. Although in the Beck et al. (1989) textbook analysis the investigators judged that the passages on the Revolutionary War assumed a good deal of knowledge, it is possible that students have accumulated that knowledge before instruction from such sources as reading, television, and general references to the period that exist in American society. Thus, to probe the extent of students' relevant knowledge, McKeown and Beck (1990) interviewed fifth graders just before they initially studied the Revolutionary period in school. The interview questions were based on two broad notions that Beck et al. (1989) indicated were largely assumed by the textbooks examined in their analysis and which they suggested are necessary for learning about the period: the role of England in the colonists' struggle for independence and ideas about representative government.

Students' responses to the interview questions were used to characterize the knowledge that target learners bring to texts about the Revolutionary period and to assess the match between what students know and what the texts assume. The results suggested that, although many students had some familiarity with events and issues related to the period, for most students this knowledge was vague and often contained inaccuracies. Thus, to a large extent, the results supported the hypothesis that knowledge assumed by the texts was not well represented in students' repertoires.

Comparison of more and less coherent text. The second problematic issue identified in the Beck et al. (1989) analysis was the less than coherent nature of the textual material. This problem was investigated by developing revised versions of textbook passages and examining students' comprehension of revised and original texts (Beck et al., 1991). The revised versions of text were developed within a cognitive processing orientation that involved simulating the process of a reader's interaction with a text. This simulation took into account a range of findings from text processing research about what causes reader/text interactions to proceed or to break down (see, for example, Graesser & Clark, 1985; Just & Carpenter, 1987; Kieras, 1985; Perfetti, 1985; Trabasso, Secco, & van den Broek, 1984). The goal of the revisions was to create a text that would assist the reader in connecting pieces of text information and combining this information with prior knowledge to develop a coherent representation. Toward this goal, the revised text was based on a causal sequence of events with the information presented in such a way as to expose the reasoning that connects a cause to an event and an event to a consequence.

At a general level, the revisions were intended to establish textual coherence by clarifying, elaborating, explaining, and motivating important information, and making relationships explicit. Because decisions underlying the revisions were so strongly tied to the specific content we present a summary of the changes in terms of the content. (A more complete description of the revisions appears in Beck et al., 1991.) The text we used comprised four segments: "French and Indian War," "No Taxation Without Representation," "Boston Tea Party," and "Intolerable Acts."

The original text on the French and Indian War failed to provide explanations of the motivation and consequences of the war between Britain and France and failed to make explicit the colonies' relationship to Britain. The goal of the revisions for this segment was to present an explicit framework for the war (who fought and why, what resulted) and lay the groundwork that would provide a setting for conflict between Britain and the colonies.

The original "No Taxation Without Representation" text segment failed to communicate the cause of the colonists' distress over taxes, in large part because it did not explain the concept of representation. The revised text explained that British citizens elected people to Parliament but the colonists could not vote in those elections and that this was the basis for the colonists' anger at being taxed by Parliament.

The original text about the Boston Tea Party, although it gave an adequate portrayal of the event itself, failed to explicate its role as a protest over Britain's taxes. The revised text explained that the colonists' anger over paying for tea stemmed from the tax on the tea. This anger about the tax is what led to colonial protests.

Finally, the original text on the Intolerable Acts did not adequately portray the desperate situation created in Boston by Britain's laws that were intended to punish colonists for the tea party. The revised text clearly detailed those punishments and explained the consequences for colonial life in Boston. The revisions were intended to help readers understand the causes of conflict between Britain and the colonies and to prepare students to understand where the intensifying conflict was leading.

The students who read the revised text showed significantly better comprehension than those who read the original text, and this included greater awareness of the role of central events in the causal sequence. However, both groups' performance indicated that they still had considerable difficulty in understanding the text. One possible hypothesis for the comprehension difficulty is the lack of background knowledge identified by McKeown and Beck (1990). It is reasonable to assume that the background knowledge problems identified in McKeown and Beck were applicable to the population used in the Beck et al. (1991) study because the subjects in both studies were from the same small, stable school district with a traditional and consistent social studies curriculum.

The present study

Given that we had, in these previous studies, examined students' prior knowledge of information related to the text and devised versions of the text passages that improved coherence, the next logical step was to examine how students would perform on the original and revised versions of the text if their background knowledge were upgraded. Thus the purpose of the present study was to provide students with relevant background knowledge and test the effects of this knowledge on comprehension of more and less coherent versions of a text. The nature of the relationship between knowledge and text structure—of which coherence can be considered an aspect—was the focus of a recent review by Roller (1990). In discussing conflicting findings about the role of knowledge and structure in text comprehension, Roller suggested that the influence of structure varies depending on the familiarity of the text content; in particular, structure is most facilitative when the content is moderately unfamiliar and decreases in importance if readers have sufficient familiarity. In this study, then, the focus of interest was whether providing background knowledge would make the content familiar enough to preclude a strong influence for the structural support provided by enhanced textual coherence.

In the present study, background knowledge was provided to all students through a carefully crafted experimenter-led presentation. Students were then assigned to one of two text conditions: the original text materials from a fifth-grade social studies textbook or the revised version of the text. The question posed in the present study was whether providing relevant background knowledge before reading would compensate for the less coherent text, or whether an advantage would still be demonstrated for the coherent text.

Method

Subjects

Subjects for this study were 48 fifth graders from an elementary school in a middle class small public school district in a northern U.S. state. Parental permission was obtained for all students who participated. Subjects were rank ordered based on their reading comprehension test scores on the Metropolitan Achievement Test. Every other student in the distribution of reading comprehension scores was then assigned to one of the two groups for the text conditions. This resulted in comparable means and standard deviations of comprehension scores for the two groups (original group, 66.46, $SD = 23.52$; revised group, 66.42, $SD = 23.62$).

Materials and procedures

All students received a prepared instructional module designed to provide relevant background knowledge for understanding the text. One of the authors presented the knowledge module, using a written script, to students in their regular social studies classes. An equal number of students in each of the two social studies classes was assigned to each text condition.

Rationale for knowledge module. The content that was presented focused on establishing and distinguishing the major agents of the Revolutionary period: the British and the colonists. This content was selected because of its role as background for the sequence of events to be presented in the text and because of evidence that such information would not typically be in students' repertoires.

The content of the knowledge module identified

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the colonies as belonging to Britain; portrayed the colonists as beginning to develop an identity of their own, separate from being British; and explained that the colonists, although under British rule, were allowed to make some of their own laws. Each of these three concepts was included to provide students with an understanding of significant features of the political and social context that existed prior to the Revolution. That is, it seems that if students failed to understand that the colonies were British, they would have little basis to understand what the colonies might want freedom from; further, the emergence of a distinct "American" identity is an important feature that motivates the desire for independence; and finally, some familiarity with governmental rights of the colonies is needed to understand why they might reject taxation without representation and what denial of self-government under the Intolerable Acts would mean.

Evidence that students might lack understanding of the selected content comes from analysis of the textbooks (Beck et al., 1989) and from an empirical study of students' knowledge about the Revolutionary context, agents, and events (McKeown & Beck, 1990). From the analysis of textbooks, we found that Britain's possession of the colonies was not strongly established in the text. The concept that colonists were beginning to develop an identity as Americans was almost completely lacking, and colonial self-government was barely given mention. From the study of relevant knowledge of fifth graders just before instruction on the Revolutionary period, we found that only about 10% of the students related the 13 colonies to Britain, about a third of the students named Britain as a participant in the Revolutionary War, and many students lacked understanding that the colonies had some powers of self-government.

Presentation of the knowledge module. To establish the purpose for the lesson, students were told that because they would soon be reading and learning about the American Revolution, which was described as "a war that the American colonists fought for their independence against Britain over two hundred years ago," they were going to talk about some things that might help them understand that time in history; specifically, they were going to talk about some of the people and places that were involved in this period.

The module began by establishing five geographic or political entities—North America, Britain, France, Massachusetts, and Boston—that are referred to in the text and about which students evidenced confusion (Beck et al., 1991). A component of the instruction aimed at introducing these entities and relating them to what students might know about their existence today. To accomplish this purpose, some map work was done, and then the experimenter introduced two side-by-side charts. One was titled "Today, about 200 years after the Revolutionary War;" the other was titled "Before the Revolutionary War, between about 1760 and 1775." Under each title, the five entities were printed down the side of the charts. The charts contained descriptors for each of the entities. These descriptors were concealed when the chart was first introduced.

Through a series of questions, the experimenter established the entities in terms of what they are today and what they were before the Revolutionary War, uncovering each descriptor as it was discussed. For example, on the "Today" chart, Britain was described as "A country 3,000 miles away from North America. Sometimes Britain is called England," and on the "Before the Revolutionary War Chart" as "The country that owned the 13 original colonies." When all the descriptors were uncovered, students were encouraged to engage with the information by using it to answer questions such as "Were the 13 original colonies near Britain?" (The relevant information on the charts was that the 13 original colonies were in North America and that Britain is 3,000 miles away from North America.)

The first portion of the module ended with a summary emphasizing that the 13 colonies were owned by the British, and that in fact, before the Revolutionary War, the 13 colonies were considered part of Britain, even though they were far away. Students were told that the discussion would now turn to "the people who lived in the 13 colonies, the people we call colonists." The intent of this section was to develop the notion that over the years the colonists were losing their British identity and developing an American identity.

To introduce this idea, the experimenter told the students that many of the people who came to the colonies in the 1600s were British. And even though they lived far away from Britain, they felt British. "Another way of saying that is: the colonists had a British identity. Someone's ***identity*** is what they feel they are. You have an American ***identity*** because you feel American." The experimenter explained that as years went by, a lot of the colonists began to lose their British identity; they began to feel separate from the British, and even began to call themselves Americans.

To encourage students to engage with the information, the experimenter asked, "Why do you think there was this change?" and provided prompts and questions toward developing the notion that the colonists had established a very different life style from that in Britain ("Let's think of what the colonists had to do when they first came over here. Did they have houses to move into? Were there stores to go to?"). Attention was also brought to the influence of the passage of time in changing the colonists' identity (e.g., "Let me tell you that a lot of time passed—about a hundred years—between when people started coming to the colonies and the middle 1700s, the time we are talking about now. Why would that help bring about changes in how the colonists felt?").

In the final portion of the identity section, the experimenter read descriptions of people, and the students decided whether the individual would be more likely to have a British or American identity. For example:

> My name is Samantha Stevens. I spent many years of my life getting a school going in our town and helping to teach the children. I am very proud of the work I've done and of how much our children learn. In Britain, only those who can afford it send their children to school. That used to seem fine to me. But here everyone goes to school—and I really think that is the way it should be!
>
> What is Samantha's identity?

Next, students were told that having thought a little about the people who lived in the colonies, they were now going to think a little about how the 13 colonies were governed. To start this section the experimenter posed the question, "Who decided how things were run in the 13 colonies—Was it the British, or was it the colonists, or was it both—the British and the colonists?" After the students made their choice, the experimenter established that both the British and the colonists were involved in running the colonies.

The experimenter explained that the 13 colonies "weren't united into one country. Each of the 13 colonies had their own little government" and that an important part of that government was something called a colonial assembly that made many of the rules and laws for the colony. It was also established that people became assemblymen through elections.

Students were then told that "in addition to the laws the assemblies made, the government over in Britain could make rules and laws that all the colonies had to follow.... So the colonies had some self-government, but they did not have complete self-government." The final governmental information presented to the students was about Britain having a king and parliament, which was where the laws were made, "something like our Congress."

The last activity, intended to further reinforce the distinctions between the colonists and the British, involved "thinking a little more about the different ways that the British and the colonists acted and thought." Here the experimenter introduced a chart that had on one side an illustration of some British characters, including King George, and on the other side some colonial characters. She then read some "quotes" that were explained as "something that someone in one of these groups might say," and the students were to decide whether it was probably said by someone in the British group or someone in the colonial group. For example, "I vote for people who go to the Massachusetts Assembly." "I can make laws for all the colonies." "My grandparents sailed 3,000 miles across the Atlantic Ocean." "I vote for people in Parliament."

In summary, the content in the 35-minute knowledge module was based on information identified as important background information that had been assumed by the textbook presentation. It is important to emphasize that the material in the instructional module did not present the sequence of events described in the text, but introduced major agents and prerequisite concepts needed to construct a representation of that sequence from the text material.

Administration of text conditions. Students were presented the text materials in individual sessions with an examiner. The examiner followed a written script that included a brief introduction, instructions, recall prompts, and short-answer questions. Each student read the text silently in four sections, one section at a time (i.e., "French and Indian War," "No Taxation Without Representation," "Boston Tea Party," and "Intolerable Acts"). Students were asked to think of the sections as passages from their social studies book. When students completed each of the four sections, they were asked to tell in their own words what the section was all about. Then students were asked a series of open-ended questions. The recalls and answers to questions were tape recorded and later transcribed for scoring.

Dependent measures and scoring

The dependent measures and scoring schemes used in this study were the same as those used in Beck et al. (1991).

Dependent measures. Measures of recall and questions were used to assess students' comprehension of the texts. Because young students' recall protocols of unfamiliar content tend to be rather limited, an extensive set of questions was developed for each passage. The questions, which were open-ended in format, focused on the sequence of events and the relationships among the people and events described in the text. For example, questions for the "French and Indian War" text segment queried: who fought the war, where the war took place, why there was a war, who won the war, and what was achieved by winning.

Scoring. To establish a procedure for scoring recall protocols, we created a textbase based on a narrative analysis technique developed by Omanson (1982) and used in our previous work (Beck et al., 1984; Beck, Omanson, & McKeown, 1982). For a full discussion of the development of the textbase, see Beck et al. (1991). Omanson's analysis identifies clauses that portray an event or state as content units. We adapted the analysis for use with expository text, which resulted in our identifying as units sequences that were often smaller than clauses. The procedures for developing the textbase involved dividing the text into clausal units, establishing separate units for any clause or phrase that represented a distinct state, event, location, or qualifier. Because of the elliptical nature of the original text, some implied units were added where inferences were deemed necessary for understanding.

Procedures for scoring recalls. Each student's recall was scored for the gist of each text unit. Scoring was done by one of the researchers, and the scoring procedure has been shown to be reliable at 91% agreement (Beck et al., 1991).

Procedures for scoring questions. Questions were scored on the basis of model answers developed by the investigators. Of the 34 questions across the four segments, 28 were scored either 0 or 1. Half credit was possible for the remaining 6 questions. As with recall, scoring was done by one of the researchers and was shown to be reliable at 94% agreement (Beck et al., 1991).

Quantitative results

The major question in the present study was how making relevant background knowledge available would affect the comprehension of more and less coherent versions of a text. In this section we present the results of the statistical analyses of comprehension performance on the original and revised texts.

Comprehension effects

The data for recall of units common to both texts and the answers to questions were examined in separate mixed design analyses of variance (ANOVAs) using text type (original versus revised) as the between-subjects factor and passage segment ("French and Indian War," "No Taxation," "Boston Tea Party," and "Intolerable Acts") as four levels of a within-subjects factor.

Insert Table 1 about here

Table 1 shows that students who read the revised text recalled a greater percentage of content units than students who read the original text, and this difference was significant, $F(1, 46) = 7.59, p < .01$. This comprehension advantage was demonstrated in students' question-answering performance as well. Table 1 shows that students who read the revised text answered more questions correctly. This difference was also significant, $F(1, 46) = 6.08, p < .05$. These findings essentially replicate the findings of Beck et al. (1991) in that they show a comprehension advantage for the revised text materials.

Table 1 Mean percentages (and standard deviations) of units recalled and questions answered correctly

	Recall[a]		Questions[b]	
	Original	Revised	Original	Revised
French & Indian War	13.3 (7.7)	19.3 (11.0)	40.6 (25.3)	42.7 (25.0)
No Taxation	11.4 (8.6)	15.4 (9.1)	33.6 (18.3)	47.5 (22.8)
Boston Tea Party	26.2 (12.8)	33.2 (16.3)	50.8 (24.9)	63.0 (29.0)
Intolerable Acts	14.7 (12.8)	31.5 (20.3)	29.2 (27.7)	60.9 (36.0)
Total	16.4	24.8	38.5	53.5

[a] The number of units for each text segment was 38, 38, 27, 21, respectively.
[b] The number of questions for each text segment was 8, 9, 8, 9, respectively.

Passage effects

There were significant differences in comprehension performance among passages for both recall and questions, recall $F(3, 138) = 34.70, p < .01$; questions $F(3, 138) = 7.71, p < .01$. There was also a significant text condition by passage interaction for both recall, $F(3, 138) = 5.37, p < .01$, and question performance, $F(3, 138) = 5.20, p < .01$. (Figures 1 and 2 graphically depict the data in Table 1.)

Insert Figures 1 and 2 about here

As can be seen in Figure 1, for both the original and the revised groups, the lowest recall performance was for the "No Taxation" text segment and the highest was for "Boston Tea Party." The significant interaction reveals, however, that the advantage for the revised group is not equal across the four text segments. The difference between the two groups' recall performance on the "Intolerable Acts" segment is more than twice that of the differences between their performance on the other three segments.

The results for the question performance show a somewhat different pattern. Both groups showed highest question performance on "Boston Tea Party." However, for the original group the lowest question performance was for the "Intolerable Acts" segment,

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Knowledge and text contributions to comprehension

Figure 1
Percentage of units recalled for each passage

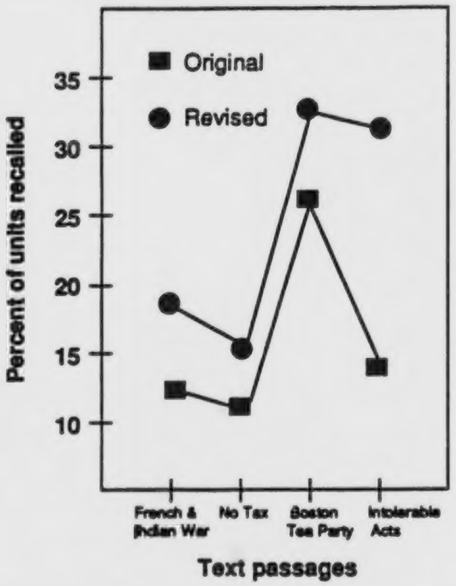
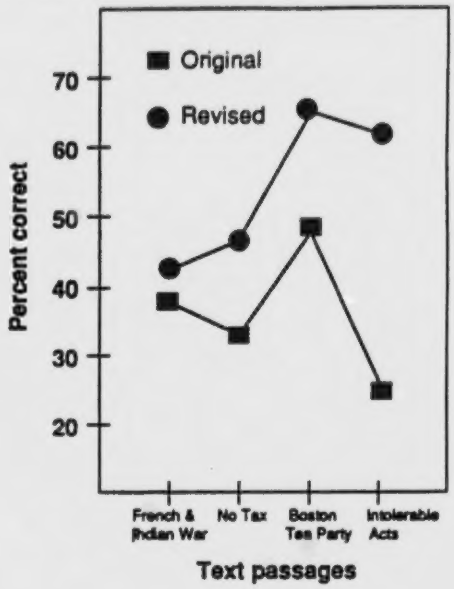


Figure 2
Percentage of questions answered correctly for each passage



while for the revised group, the lowest question performance was for "French and Indian War." Further, as indicated by the interaction depicted in Figure 2, the difference in performance of the two groups on the "French and Indian War" passage is not comparable in magnitude to the comprehension advantage seen for the revised group on the other three passages.

The pattern described may be a consequence of the interaction of the strong schema for Britain and the colonies established in the knowledge module and the revised text's more extensive foreshadowing of the upcoming Revolutionary conflict. Because the most salient part of the discrepant patterns is the relatively poor performance of the revised group on the questions for the "French and Indian War" segment, we looked at the responses to the eight individual questions and found that the revised group had relatively poor performance on three of the questions. Specifically, the questions concerned who had the land before the war, what Britain got from the French and Indian War, and how the colonies were getting along with Britain right after the war. In regard to who had the land before, the most common incorrect response was the Indians, and we cannot speculate as to why this occurred.

As for the two other questions, however, the revised group's responses indicated that they may have accessed their knowledge about the British and colonial antagonism gained from the knowledge module too early in the text sequence. That is, they often responded that the British had won the colonies as a result of the French and Indian War and that the British and colonists were not getting along well after that war.

Responses to the three questions discussed reduce the advantage for the revised text. For the subsequent three text segments, however, the difference in favor of the revised text is much more apparent.

Qualitative results: A closer examination of knowledge effects

The results of this study indicate a clear advantage for the revised text and therefore suggest that a rather extensive prior knowledge lesson that introduced information relevant for comprehending the text did not compensate for the lack of coherence in the text. However, finding that prior knowledge provided no enhancement for comprehension would be in contrast with arguably the strongest, most consistent finding in recent reading research (see, for example, Roller, 1990). Thus, the results warrant a closer look.

An examination of the results from the present study in conjunction with the results of Beck et al. (1991), which originally found a comprehension advantage for the revised texts without a knowledge component, reveals differences that may shed some light on the, in this case, elusive effect of prior knowledge. Although many cautions need to be made when making comparisons across studies, we believe we have a strong case for why it is legitimate to compare the data of these two studies in particular. First, the samples are similar in that the students came from the same small, stable school district, they had the same social studies curriculum and the same fifth-grade social studies teacher, and their ability levels as shown by their reading comprehension achievement test scores were very comparable. In the present study, the mean comprehension score was 66.44 (*SD* = 23.3) and in Beck et al. (1991) 61.6 (*SD* = 22.3). Further, the conditions of the studies were similar in that the same experimenter was in charge of running the subjects and scored the recalls and question responses for both studies.

Most compelling is the fact that the pattern of differences in performance across studies is well accounted for by the presence or absence of the factors investigated in the studies, background knowledge and text coherence. This pattern, in conjunction with the similarity of the samples and conditions of the studies, seems to rule against reasonable alternative hypotheses for the observed differences. Additionally, no event that could significantly differentiate the history of the subjects in the two studies was noted, nor could we hypothesize one that would pose a competing explanation for the pattern of differences observed.

The pattern of differences across the studies creates a revealing picture of the differential effects of knowledge and text coherence. In order to consider these patterns, we first present a brief review of the results of Beck et al. (1991), hereafter referred to as the revision study.

Table 2 Mean percentages (and standard deviations) of units recalled and questions answered correctly by students in the revision study (Beck et al., 1991)

	Recall[a]		Questions[b]	
	Original	Revised	Original	Revised
French & Indian War	11.3 (8.5)	14.6 (12.1)	30.9 (26.0)	50.8 (27.1)
No Taxation	8.3 (8.0)	15.0 (11.0)	22.4 (24.2)	38.3 (26.5)
Boston Tea Party	21.6 (12.2)	26.6 (12.0)	41.9 (31.0)	61.7 (25.1)
Intolerable Acts	13.1 (11.5)	17.9 (15.5)	24.3 (29.3)	45.6 (33.0)
Total	13.6	18.0	29.9	49.1

[a] The number of units for each text segment was 38, 38, 27, 21, respectively.
[b] The number of questions for each text segment was 8, 9, 8, 9, respectively.

The revision study

The primary question in the revision study was whether the revised text produced better comprehension than the original text. As Table 2 indicates, the results of this study showed that students who read the revised text recalled a greater number of content units from the text and answered more questions correctly than the students who read the original text. These differences were significant.

Discerning patterns of facilitation of knowledge and coherence

We can begin our quest for the possible effects of prior knowledge on comprehension by comparing the data in Table 1 to the data in Table 2. As indicated, the percentage of units recalled and questions correctly answered is an average of 5% higher for the groups in the present study than for their counterparts in the revision study. Thus there is some suggestion of an overall facilitative effect of the prior knowledge component. But this overall view is not the comparison of primary interest. Rather, the most compelling evidence for the effects of knowledge and text lies in the pattern of differences across the four groups in the two studies, particularly in students' responses to specific questions.

The pattern of differences suggests where knowledge from the module facilitated comprehension of the original text, where that facilitating effect was limited, and where the combination of information presented in

Table 3 Percentage of target questions correctly answered for the "No Taxation Without Representation" text segment

Text condition Knowledge module	Original text —	 +	Revised text —	 +
	OT[a]	OT/K	RT[a]	RT/K
Questions targeting agents and attitudes				
1. Who is being asked to pay taxes?	53	92	71	88
2. How do the colonists feel about the taxes?	48	79	71	96
Questions targeting representation principle				
3. What does it mean that the colonists were not members of Parliament?	10	8	38	46
4. Why are the colonists upset about the taxes?	8	13	16	33
5. What does "no taxation without representation" mean?	13	17	40	54

[a] Data in these columns are based on data reported in Beck et al. (1991).

the knowledge module and more coherent text provided enhanced facilitation. These effects are best revealed if we examine two critical aspects of text content, which had been identified earlier in our work (McKeown & Beck, 1990) as lacking in students' background knowledge repertoires. These aspects involved, first, the role of the major agents—the colonies and Britain—and their attitudes toward key events, and, second, the principle that drove the colonists' actions, representative government. As noted earlier, the knowledge module emphasized these two aspects. Information about the agents and their roles was directly presented to help students set up a conflict framework as they read; information about Britain's governance of the colonies and the colonists' powers of self-government was presented to set up a framework in which to understand the colonists' desire for representation.

Included in the sets of questions that we developed for the texts were questions that targeted both of these aspects. In this section we organize the discussion around these target questions for three of the four sections of text used in the revision study and the present study. Here we omit discussion of the "French and Indian War" section because we have already discussed hypotheses for the effect of the knowledge module on the readers of the two different versions of that text segment. In particular, it appeared that the information about agents in the knowledge module, in conjunction with the more extensive foreshadowing of the Revolution in the revised text, may have caused the readers of the revised text to access their Revolutionary schema too early in responding to questions. Additionally, the questions for the "French and Indian War" segment are the least relevant for the two aspects we are examining: the agents and their attitudes and the principle of representative government. The intent of the "French and Indian War" text segment was to set up a situation from which conflict between Britain and the colonies eventually grows, that situation being Britain's taxation policy. But this segment itself does not set up that conflict, nor does it concern the representation issue. Thus the questions for the segment do not reveal the pattern of differences that we focus on in this discussion.

No taxation without representation. For the "No Taxation" section we focus on five questions, two of which concern the identity of the major agents and their attitudes toward each other and three of which tap understanding of the principle motivating the colonists' actions. These two sets of questions and the percentage of correct response to each by the four groups are shown in Table 3.

We first consider the agent questions (Questions 1 and 2), which query who is being asked to pay taxes and how the colonists feel about them. Performance on these two questions reveals the facilitating effect of the background knowledge module. That is, students who read the original text and received the knowledge module (the OT/K group) demonstrated a large advantage over those students who read the original text without the knowledge module (OT). Specifically, for the first question, the OT/K group demonstrated an advantage of 39% (92% versus 53%), and for Question 2, 31% (79% versus 48%). A similar advantage was shown on Questions 1 and 2 for those students who read the re-

Table 4 Percentage of target questions correctly answered for the "Boston Tea Party" text segment

Text condition:	Original text		Revised text	
Knowledge module:	−	+	−	+
	OT[a]	OT/K	RT[a]	RT/K
Questions targeting agents and attitudes				
1. What was the Boston Tea Party?	73	92	80	80
2. Who took part in the Boston Tea Party?	50	83	78	88
Questions targeting principle				
3. Why were they upset about a small tax?	25	33	44	46
4. Why did they throw tea into the water?	28	38	49	58

[a] Data in these columns are based on data reported in Beck et al. (1991).

vised text and received the knowledge module (RT/K) over those students who read the revised text without the knowledge module (RT). For Question 1 this difference was 17% (88% versus 71%) and for Question 2, 25% (96% versus 71%). This advantage suggests that students were using information from the knowledge module to help them distinguish the roles of the agents in the text and perhaps also drawing on information from the module about Britain's governance of the colonies, that is, that Britain could pass laws that the colonies had to follow.

A somewhat different picture of the effect of knowledge emerges when we consider the questions involving the principle underlying the colonists' actions (Questions 3, 4, and 5). The scores were very similar for the two groups who read the original text. Thus, it seems that students who had the knowledge module (OT/K) were not able to apply that knowledge to better understand the basis for the colonists' distress over Britain's taxes. In fact, across the three questions that tap the representation principle, the highest percentage of correct responses to any of these questions for the two groups that read the original text is only 17%. In contrast, knowledge combined with the greater coherence of the revised text did seem to play a role in how students responded to these three questions. The RT/K group shows advantages ranging from 8 to 17% over the RT group for the three questions that targeted the principle.

It is possible to consider whether there were separate effects of knowledge and coherence by comparing the performance of students who read the revised text without the knowledge module (RT) to those who read the original text with the knowledge module (OT/K). Coherence seems the stronger influence, as shown by the performance of the RT group on the questions involving the principle motivating the colonists.

Boston Tea Party. The questions for the "Boston Tea Party" segment that tap the agents' roles and the motivating principle underlying the colonists' actions are shown in Table 4. As in the "No Taxation" section, students who read the original text and received the knowledge module (OT/K) showed higher performance on the agents and attitudes questions (Questions 1 and 2) than students in the OT group, but that advantage did not extend strongly to the questions involving the principle. Specifically, the advantage for Question 1 was 19% for the OT/K group (92% versus 73%) in understanding that the tea party was the colonists' action of throwing tea in the water. For Question 2 the advantage was 33% (83% versus 50%) in understanding that it was the colonists who took part in the tea party. Interestingly, these advantages are for two questions that were relatively well responded to by the OT group. Thus the advantage is shown for two of the easier, more basic questions.

For students who read the revised text, the effect of the addition of knowledge is not clear for the agent questions. For Question 1, the scores of the RT and RT/K groups are identical, while for Question 2, which is a question based on essentially the same content, the RT/K group showed a 10% advantage. It can be noted that for these two groups, as well as for the OT/K group, performance is quite high, with more than three quarters of the students correctly responding to both questions.

For this text segment, Questions 3 and 4 relate to the principle. Question 3 asked why the colonists were upset about a tax that was described in the text as "small"—in order to see if students realized it was not

Table 5 Percentage of target questions correctly answered for the "Intolerable Acts" text segment

Text condition: Knowledge module:	Original text –	 +	Revised text –	 +
	OT[a]	OT/K	RT[a]	RT/K
Questions targeting agents and attitudes				
1. How did the British feel about the Boston Tea Party?	56	88	88	90
2. Why did they close the Port of Boston?	15	25	38	50
3. What was intolerable?	15	21	40	67
4. How did the people in the other colonies feel about what was happening in Boston?	25	21	36	63
Questions targeting principle				
5. What does it mean that no self-government was allowed?	15	25	27	63

[a] Data in these columns are based on data reported in Beck et al. (1991).

the amount of money that bothered the colonists but that the tax was being levied without their say. Question 4 queried the colonists' reasons for throwing tea into Boston Harbor to tap whether students understood it as an act of protest against Britain's taxes. The OT/K group shows only modest advantages over the OT group on these questions. For Question 3, there was an 8% advantage, and for Question 4 there was a 10% advantage.

A similar picture of, at best, a modest advantage holds for the effect of knowledge in addition to the revised text for the two principle questions. Specifically, for Question 3 the RT and RT/K groups show a nearly identical score, and for Question 4 the RT/K group shows a 9% advantage. Further, these two questions indicate the stronger influence of text coherence over background knowledge. That is, both groups who read the revised text show advantages ranging from 11 to 20% over the OT/K group.

In general, the pattern of question responses for the "Boston Tea Party" segment suggests that it was fairly easy to help students understand that the colonists were the main actors in the events described in this text segment, but it was much more difficult to upgrade their understanding of the principle behind the colonists' actions. Yet the enhancements of knowledge and text coherence did provide assistance, even though the magnitude of that assistance was not large. And, a pattern emerges that suggests that knowledge helped readers of the original text, text coherence provided more help than the addition of knowledge to the original text, and knowledge in addition to coherence provided the most facilitation.

Intolerable Acts. For the "Intolerable Acts" segment, we again consider questions that focused on the agents' roles and attitudes and on the principle of representation in government. The questions and the percentage correct for each group are shown in Table 5. But, as will be discussed shortly, the distinction between the two categories of questions is less clear in this segment. Question 1 is the clearest example of a query about the attitude of a major agent, that is, how the British felt about the Boston Tea Party. In keeping with the pattern that is emerging, there is a striking 32% advantage for the OT/K group (88% versus 56%) over the OT group.

The RT/K group did not show such an advantage for Question 1, but this likely represents a ceiling effect, as the RT group's response was already 88%. For Question 2, which asks about an action that stemmed from Britain's attitude about the tea party, an advantage is also shown for the OT/K group, although it is much smaller (10%). The RT/K group shows a similar advantage over the RT group for Question 2.

The remaining two agent and attitude questions (Questions 3 and 4) have a rather different quality in that they require more than the realization that Britain and the colonies are on opposing sides in a conflict. For example, the answer to Question 3, "What was intolerable?" is that "intolerable" is what the colonists dubbed Britain's new laws. Understanding why the colonists used this term involves some realization of the intensity of the reaction of the colonies to the laws. The colonists' strong reaction sprang from their belief that they had just cause for what they had done, because Britain had violated a principle that they held dear.

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Question 4, which asked, "How did people in other colonies feel about what was happening in Boston?" is also a complex question. It requires understanding that the colonies were not one single entity in opposition to Britain, but a collection of entities that were drawing together and developing a united opposition.

For both Questions 3 and 4, the enhanced knowledge of the OT/K group was not sufficient to allow students to reach the more complex understandings needed to respond to these two questions. But knowledge in combination with the greater coherence of the revised text had a powerful effect, as the RT/K group outpaced the RT group by 27% on both questions. A comparison of the RT group to the OT/K group shows that text coherence had a greater effect than knowledge on the understandings needed for these complex questions. That is, the RT group showed an advantage over the OT/K group on both questions.

Question 5, which asks about the meaning of Britain's disallowance of self-government, is the only question directly involving the principle of representation for this text segment. Although the OT/K group shows a 10% advantage over the OT group in response to Question 5, even with this advantage only a quarter of the students responded correctly. This brings the OT/K group's response level in line with that of the RT group. The effect of knowledge in addition to coherence, however, brings a striking advantage for the RT/K group, with 63% of the students giving a correct response. This is a powerful illustration of the effect of the combination of background knowledge that the colonists had had some powers of self-government with a coherent explanation in the text that some of their rights were taken away.

The overall pattern. It seems clear from considering the pattern of differences among the groups in response to questions about key aspects of text content that enhancement due to background knowledge was not an overall general effect. Rather, knowledge affected the original and revised texts quite differently. When questions required distinguishing the basic roles of the major agents or discerning their attitudes toward key events, the knowledge module played a strong role for readers of the original text. In contrast, the knowledge module never provided a strong advantage for these readers in understanding the principle underlying the colonists' actions or in comprehending more complex aspects of the agents' roles. At most, modest advantages were seen for some of these questions.

For readers of the revised text, knowledge played at least a moderate role for questions concerning agents, except in two cases where correct response was already at 80%. Questions involving principle or more complex aspects of agents' roles generally showed larger advantages for these readers than for readers of the original text.

In comparing the knowledge effect to the coherence effect, as embodied in the OT/K and the RT conditions, coherence seems the stronger enhancement for understanding complex content. The two enhancements together, in the RT/K condition, seem particularly potent in this regard, often providing an advantage beyond the sum of what the two provide separately. This large advantage is especially evident for a number of questions in the "Intolerable Acts" text, the final segment in the sequence. It is difficult to trace the advantage of the RT/K group for questions on this segment to specific information from the knowledge module, or to determine how specific information might have interacted with certain text statements. Rather, this advantage may suggest an accumulating effect of the two enhancements, knowledge and coherence, that allowed the RT/K group to construct a more complete representation of the event sequence being portrayed.

Discussion

In investigating the relative contribution of knowledge to comprehension of more and less coherent text, we anticipated either of two possible outcomes. The first was that upgrading students' background knowledge would override the comprehension advantage for the revised text. The rationale for this possibility is that, given appropriate background knowledge, students could bring that knowledge to bear on the rather elliptical nature of the original text and make the connecting inferences needed to bring coherence to the material. This line of thinking coincides with Roller's (1990) discussion of the interaction of text structure and background knowledge. That is, clear and logical structure of a text—which can be likened to our concept of coherence in many respects—is most useful to readers encountering text in moderately unfamiliar domains. Thus it might be posited that the knowledge module would have provided enough familiarity with the content to override the need for the kind of structural support present in the coherent text.

The other possibility was that background knowledge in addition to more coherent text would result in better comprehension than coherent text alone. The notion here is that, given the conceptual difficulty of the material, two sources of support, coherent text *and* background knowledge, would give rise to better comprehension rather than either source overriding the effect of the other.

As is clear from the results, it was this second possibility that prevailed. The students who read the revised text were able to utilize the knowledge gained from the background knowledge instructional module to focus on and remember the most important information from the text. This was particularly evident from the examination of responses to questions. The revised group was most successful in responding to key questions that indicated some grasp of the principles motivating the colonists' actions.

The students who read the original text, although they received the same background information, were less able to exploit the advantage provided by that information. It seems that the nature of the original text prevented students from bringing their knowledge to bear in constructing meaning from the text. The effect of upgraded knowledge on the readers of the original text seems to be the other side of the coin to Roller's (1990) argument that text structure has differential effects for different levels of knowledge. That is, the present results suggest that background knowledge is most useful if the text is coherent enough to allow the reader to see the connections between the text information and previous knowledge so that the knowledge can be combined with the text information to create a meaningful representation.

Regarding the effect on text comprehension of the knowledge provided by the background knowledge instructional module, one additional finding begs further comment. The finding, which was presented earlier, is that of the comparatively poor performance of the revised group on the questions about the French and Indian War. As was mentioned previously, the hypothesis is that this finding is traceable to the emphasis created in the instruction on the diverging identities of the actors in the Revolutionary War, which likely drew attention away from the specifics of the French and Indian War. This finding is worthy of note because it represents an example—created inadvertently—of a phenomenon that is currently prominent in the literature on background knowledge. The phenomenon is that of background knowledge overriding text information in such a way that readers recall text or respond to questions with information from their knowledge base, even though it is not supported by—and in some cases is even contradictory to—the text (Alvermann, Smith, & Readence, 1985; diSessa, 1983; Dole & Smith, 1987; Lipson, 1982; Marshall, 1989; Schoenfeld, 1985). In the case at hand, it appears that students depended on their either newly acquired or newly activated schema about the Revolutionary period to answer questions about the earlier war presented in the text.

The research reported here also addresses the issue of the contribution of textbooks to social studies learning, particularly in relation to the teacher's role in mediating text information. Elementary-text-based lessons—be they in reading, science, or social studies—as represented in the teacher's manuals that accompany textbook series are initiated with a preparation component. Preparation components are teacher-initiated activities, often teacher-led discussions, through which the teacher attempts to provide the students with skills and background knowledge related to the upcoming textual material. The information provided might include, for example, a context for a story, the meanings of some vocabulary, or explanation of a concept. It is conventional wisdom that the teacher has a significant role in "preparing" elementary students for the textual materials they will encounter, although there are differences in what is recommended across grade levels, textbook series, and subject matters, as well as individual differences among teachers.

One such difference across subject matters is apparent in even a cursory comparison of teacher's manuals for reading and social studies. The suggestions in the preparation component for social studies are far less extensive than those found in reading textbook series. The more extensive preparation components for reading selections may have developed because, given that reading is a process and not a subject matter, what students can read about in a reading program can be chosen from the multitude of topics in the world (Beck & McKeown, 1989). Thus, because reading programs tend to be a smorgasbord of content with frequent, often daily, changes in topic, there is obvious need to provide background. In contrast, the less extensive preparation component in the social studies teacher's manuals may have its roots in the notion that a content area textbook is by definition sequentially developed so that early chapters serve as background for subsequent chapters.

The results of this study in combination with those of the revision study (Beck et al., 1991) suggest that the notion of sequenced content as background, at least for social studies texts as they are now written, is a fallacy. Previous text content as background, represented in the original text condition of the revision study, fell far short of preparing students for understanding text content about events leading to the Revolutionary War. This result demonstrates the need for teacher intervention, and rather substantial intervention at that. As discussed in Beck et al. (1991), the original group received regular classroom instruction accompanying the content leading up to the tested material, which included teacher intervention at least at the level prescribed in the teacher manual.

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Another wrinkle in the prescription of teacher intervention is revealed by virtue of the performance of the two groups in the present study. That is, the original textbook passages, coupled with fairly extensive teacher intervention to provide background knowledge, yielded comprehension that was below that of students who received the preparation component and the revised text. This result counters another argument sometimes put forth in the debate on textbooks; that is, efforts to make textbooks more coherent are unnecessary because the teacher fills in much information which will make up for many gaps in the text material. As the research reported here has shown, extensive preparation to provide background knowledge did not compensate for the inadequacies of the text; there was still a substantial advantage for the revised text.

This study has shed some additional light on the contribution to text comprehension of two important components of that process, background knowledge and text coherence. As Roller (1990) has pointed out, text structure and background knowledge interact in their effect on comprehension. Knowledge of varying degrees can compensate for varying levels of structure—or, in the present study, coherence. Similarly, greater coherence can compensate for some knowledge gaps. Our portrayal of interaction is one in which both variables are individually effective, but neither variable can completely compensate for inadequacies in the other.

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AUTHOR NOTES

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INCLASS OR PULLOUT: EFFECTS OF SETTING ON THE REMEDIAL READING PROGRAM

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ABSTRACT

The purpose of this study was to describe the remedial reading instruction received by students assigned to inclass or pullout programs with respect to the instructional behaviors of teachers, the nature of lessons, and the reading behaviors of students. The study was conducted in an urban school system in which the pullout and inclass programs existed concurrently. One hundred nineteen students (Grades 4 and 5) were observed over a 4-month period. In both settings, students received a great deal of skill-related instruction; not much time was spent in prereading activities and students spent most of their time with worksheets. Over 60% of classroom time in both settings was spent in listening, transcribing, and silent reading. Pullout students experienced more direct teaching activities in a group situation while inclass students experienced more time in a one-on-one tutoring mode. Overall, there were differences between settings in what students experienced in remedial reading.

Many concerns have been raised about the prevailing model used in Chapter I programs—the pullout model that provides supplemental compensatory instruction to participating students. Critics of pullout programs question the lack of congruence with the developmental reading program (Allington & McGill-Franzen, 1988; Allington, Steutzel, Shake, & Lamarche, 1986; Johnston, Allington, & Afflerbach, 1985), the loss in instructional time in moving from classroom to pullout setting (Allington et al., 1985); and the negative effects of labeling students (Glass & Smith, 1977; Leinhardt & Pallay, 1982).

Moreover, results of the latest national assessment of Chapter I have indicated that: (a) although students receiving Chapter I services demonstrated larger standardized achievement test gains than comparable students not receiving Chapter I services, their gains did not move them substantially toward the achievement level of more advantaged students; (b) participants in math gained more than those in reading; and (c) students in the early grades gained more than students in later grades (Kennedy, Birman, & Demaline, 1986). These results are consistent with the accumulating evidence and concern about the overall effectiveness of Chapter I (Carter, 1984; Cooley & Leinhardt, 1980; Coulson et al., 1977; Kaestle & Smith, 1982; National Institute of Education (NIE), 1978; Slavin, 1987; Wang, 1980).

Given concerns about pullout programs, several alternative models have been proposed, including an inclass model in which the reading specialist works with students in the classroom alongside the regular or developmental reading teacher. Although proponents assume that the inclass model will eliminate problems such as lack of congruence, loss of instructional time, and labeling, there is little evidence to support these assumptions. Indeed, there are concerns that the inclass model may generate new problems that may also reduce program effectiveness (Bean & Eichelberger, 1985; Harpring, 1985).

The purpose of a larger study (Bean, Cooley, Eichelberger, Lazar, & Zigmond, 1988), of which the work reported here is a part, was to investigate systematically the variables that appear to be critical to effective reading instruction as they occur in two different Chapter I programs, inclass and pullout, and to determine the effects of these variables on student achievement. In the larger study we looked at both developmental and remedial programs and the congruence between the two programs. In this paper, we focus our attention only on the remedial reading program with respect to the following questions: What is the nature of the remedial reading program for students in an inclass and a pullout setting? How do these programs differ in: (a) the instructional behaviors of the reading specialists, (b) the nature of the lessons, and (c) the reading behavior of students? We were especially interested in describing the nature of the reading instruction received by students, that is, how they were spending their instructional time when they were with the remedial teacher and when they were working independently.

METHOD

Subjects

This study was conducted in a large city school system in which the two different settings for remediation existed concurrently. Schools within the district with smaller numbers of students and, therefore, fewer students eligible for Chapter I, used a pullout model for their Chapter I reading program, whereas the Chapter I reading program in larger schools was inclass in nature. The decision regarding setting was made at the district level and was related to difficulties in scheduling remedial reading teachers assigned to handle students in two or three schools. The objectives and philosophy as well as instructional techniques for the Chapter I reading program were consistent across the district, however; helping students to be successful in the classroom reading program was emphasized as an important aspect of the Chapter I program, regardless of setting. The fact that we could study a Chapter I reading program that consisted of both inclass and pullout models in a single district enabled us to control for reading philosophy, materials, community characteristics, and teacher quality to a greater extent than if we were studying each type of setting in a different school district.

One hundred nineteen students (Grades 4 and 5) participating in Chapter I remedial reading programs in 12 schools (4 inclass; 8 pullout) were observed systematically over a 4-month period while receiving reading instruction from their remedial reading specialists. All students had scored at the 30th percentile or below on the California Achievement Test (1987), Total Reading, the previous spring. Of the 119 students, 66 students (27F, 39M) received remedial instruction in an inclass setting and 53 (20F, 33M) in a pullout setting.

Nine reading specialists served these 119 students in 12 schools (one at 3 of the schools, another at 2 schools, and the remaining at one school each). The participating schools were scattered geographically throughout the school district. The level of poverty in participating schools ranged from 25% to 75% of students eligible for free lunch. The percent of school populations participating in Chapter I programs ranged from 5.0% to 9.4%. School sizes ranged from a total school population of 168 students to a school population of 476.

In the pullout setting, students left their regular or developmental classroom at some time other than during reading instruction to receive instruction from the reading specialist. Specialists saw no more than 10 students at a time, and students received instruction for 100 minutes per week (two and one half 40-minute periods). In the inclass setting, the reading specialist went to the classroom during reading instruction two or three times per week, observed for half of the 40-minute period to determine the focus of the classroom teacher and possible needs of the students, and then worked with the identified students (no more than 10) for the remaining time (a total of 50 minutes of instruction per week).

Materials

Observational data on teacher behaviors, lessons, and student behaviors were obtained through the SORIN (System for Observing Reading Instruction), a time-sampling observation protocol that enabled the observer to specify the amount of time spent on designated instructional activities as well as on selected teacher and student behaviors. The coding system was designed by the researchers (Bean, Lazar, & Zigmond, 1987) to yield information on the students' activities and experiences during the time allocated to reading instruction. Qualitative information about the specific materials used, nature and size of group, and content of lessons were also recorded.

In developing the observation instrument, findings of prior research about instructional practices that are related to reading achievement were used to provide initial observation categories (see Kohnke, Miller, & Zigmond, 1986; Leinhardt & Seewald, 1981). Further, three basic beliefs as to what constitutes effective reading instruction guided us in designing the instrument: (a) reading is more than a hierarchically arranged set of subskills which can be systematically taught and then tested, (b) students need opportunities to experience reading of connected text, and (c) students who are experiencing reading difficulties profit from direct instruction designed to help them make sense of what they are reading (Adams, Anderson, & Durkin, 1984; Allington, 1984; Anderson & Scott, 1978; Bourque, 1980; Duffy, Roehler, & Mason, 1984; Paris, Lipson, & Wixon, 1983; Rosenshine, 1980, 1986; Solomon & Kendall, 1979; Winograd & Greenlee, 1986.) Our observation system, therefore, was designed to enable us to get a picture of students' experiences relative to each of these beliefs. Table 1 illustrates categories for the three dimensions investigated, which are also described below.

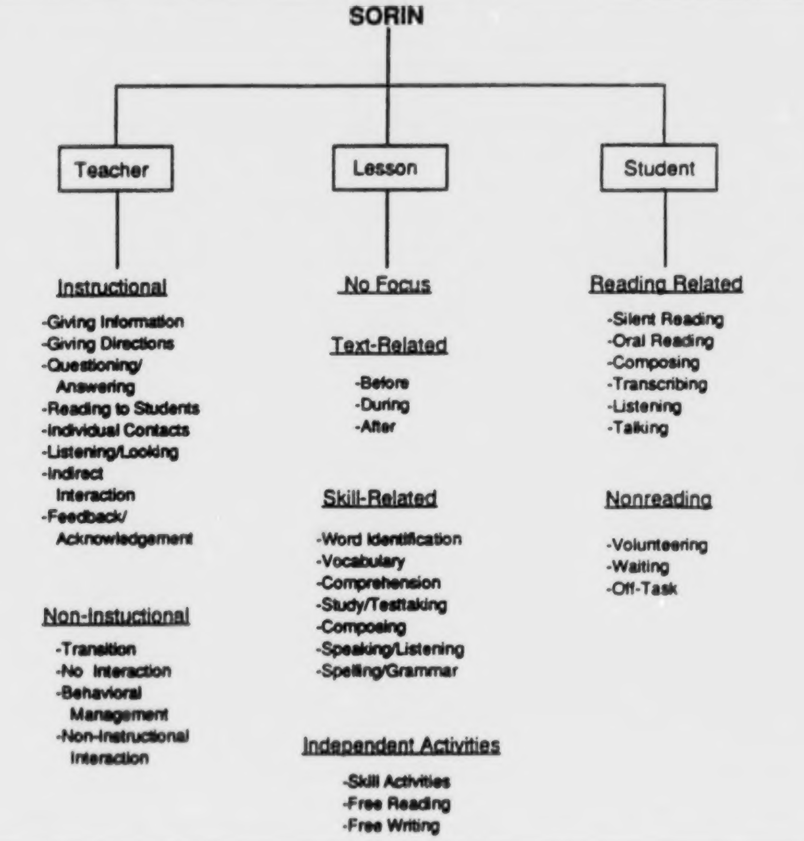
Although reading instruction is generally presented to groups of students, the activities and experiences of individual students often differ. For example, although one student may be reading orally, another may be listening; one student may be involved in a teacher/student dialogue while another is inattentive. Our goal was to describe the reading experiences of students in each setting; for that reason the unit of observation and analysis throughout the study was the individual student.

Teacher behaviors. In the first phase of each observation cycle, students were observed to determine the nature of the teacher behaviors each was experiencing. The two basic areas of teacher behaviors recorded were instructional and noninstructional. Given the focus on compensatory reading, instructional behaviors included such behaviors as: teacher working individually with one student (individual contacts) and monitoring students while they completed an assignment (listening/looking). Noninstructional behaviors were those behaviors that did not in any way pertain to instructional content or method (see Table 1). The observers systematically observed each child for 5 seconds, then coded the teacher behavior experienced by that child during the next 5 seconds; then the observer followed the same procedure with the next child listed on the observation protocol. Student experiences of teacher behavior were coded 7 times, evenly spaced throughout the observation period.

Lesson. In the second phase of each observation cycle, data were collected on three dimensions of the lesson: lesson focus, types of materials used, and level of materials. Within the first dimension, no focus reflected that, for the student being observed, there was no discernible instructional focus at the time of the observation (e.g., student sitting around waiting for a lesson to begin while the teacher was organizing materials or writing on the chalkboard). A student was coded as being involved in a text-related lesson (TRL) if the instructional focus was centered on a selection of written text. These TRLS were further coded into activities occurring

Table 1

Categories in the SORIN Observation System


SORIN
Teacher
Lesson
Student
Instructional
-Giving Information
-Giving Directions
-Questioning/ Answering
-Reading to Students
-Individual Contacts
-Listening/Looking
-Indirect Interaction
-Feedback/ Acknowledgement
Non-Instuctional
-Transition
-No Interaction
-Behavioral Management
-Non-Instructional Interaction
No Focus
Text-Related
-Before
-During
-After
Skill-Related
-Word Identification
-Vocabulary
-Comprehension
-Study/Testtaking
-Composing
-Speaking/Listening
-Spelling/Grammar
Independent Activities
-Skill Activities
-Free Reading
-Free Writing
Reading Related
-Silent Reading
-Oral Reading
-Composing
-Transcribing
-Listening
-Talking
Nonreading
-Volunteering
-Waiting
-Off-Task

before, during, or after reading of text. Vocabulary development activities or development of prior knowledge before reading a text selection were considered *before* reading activities. Guided oral or silent reading or the asking of questions interspersed with reading were considered *during* reading activities. *After* reading activities consisted of discussions or comprehension questions raised after a selection was completed.

A student was coded as participating in a skill-related lesson (SRL) if the

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teacher was providing direct instruction on various types of skill activities. Students working independently (IW), whether on skill assignments, free reading, or writing, was recorded as a separate dimension.

Students' experiences with various types of materials were also coded. Observers identified whether the student being observed was working with basal text, content text, tradebook, worksheet or workbook, or other material commonly used during reading instruction.

The final dimension coded in the Lesson section of the SORIN was level of activity as reflected by the nature of the materials with which each student was working. The word level indicated experiences with materials which focused on letters or words in isolation; sentence or paragraph level materials focused on working with sentences or paragraphs (e.g., worksheets in which students were identifying the main idea or drawing conclusions after reading a short paragraph of text); selection level indicated experiences with narrative or expository text (including the followup discussion or completion of activities in which students were responding to questions about a selection). For the lesson dimensions, a student was observed for 5 seconds and then the appropriate codes for the focus, type, and level of materials were recorded. The observer then followed the same procedure for the next child on the observation protocol. Student experiences during a lesson were coded 7 times, evenly spaced during the observation period.

Student behavior. The third phase of each observation cycle focused on what each student was doing during reading instruction. Included in this component were both direct reading behaviors (silent and oral reading) and activities related to reading (composing, transcribing, listening, or talking). In addition to these reading categories, three nonreading behaviors were coded (see Table 1). For this dimension, a student was observed for 5 seconds and then during the next 5 seconds the observer coded the behavior. This procedure was then followed for the next child on the observation protocol. Student behaviors were coded 6 times, evenly spaced during a 40-minute observation period.

Procedure

Observations were conducted by 11 observers, all of whom were either reading specialists or had taught reading in some context and had a working knowledge of reading terminology. Observers were trained using an instructional manual, simulation experiences in a lab situation, and field experiences, until they reached criterion performance of 85% agreement with the trainer. After criterion was reached, interobserver reliability checks were conducted every two weeks (15% of the total observations of each observer). Interobserver reliability remained high throughout the study (>.85).

The observations of these 119 students took place over a 16-week period. For pullout programs, we observed during the complete 40-minute lesson period. For inclass programs we observed the remedial instruction during the 20-minute segments of two separate periods. (Additional observations of students' developmental classes were also made and are reported in Bean et al., 1989.) For each remedial class, we sampled 40 minutes of instruction, every other week, for a total of 8 periods of instruction (5 hours and 20 minutes) over the 4-month period. The decision regarding when to observe was based upon: (a) the schedule of the remedial teacher, and (b) the need to observe each child with both the remedial and developmental teacher on the same day or on consecutive days to obtain measures of congruence (reported in Bean et al., 1989).

Scoring. Based upon the raw counts obtained through SORIN, the frequency with which students experienced various activities was obtained and the mean percent for each frequency calculated. The time allocated for remediation in each of the settings (50 minutes a week for inclass students and 100 minutes a week for pullout students) was used to transform the mean percent of frequencies to the percent of time per week that students spent in specific activities and to determine how total amount of time in remedial reading was spent.

RESULTS

Tables 2–6 list the percentages of remedial time students spent in various reading or instructional activities across the two settings. Differences in the percent of weekly time spent in each category were compared (t tests are reported in Tables 2–6). Given our interest in investigating the differences in time students spent in the various reading activities across setting and the need to know whether those differences were significant, statistical analyses were conducted. The relative sizes of the t statistics provide a basis for such comparisons. The significance level was set conservatively at .001 to minimize Type I errors that might result from the large number of comparisons made. In the following sections, we discuss the differences in the remedial instruction across settings for the three areas in the SORIN (teacher behaviors, lesson, and student behaviors).

Teacher Behaviors

The first section of the protocol permitted an analysis of the teaching behaviors experienced by students (see Table 2). In the pullout setting, students spent 78.1% of remedial reading time receiving instruction from the teacher and 5.7% of time in noninstructional activities. The remaining 16.1% of the time was coded as "scheduled instruction ceased," that is, the lesson had been completed and students were involved in activities other than the specific reading lesson being observed (waiting for the next lesson to begin or waiting to return to their classrooms). In looking specifically at the instructional practices, students in the pullout remedial

Table 2

Percentage of Remedial Reading Time Students Were Recipients of Various Reading Specialist Behaviors in Inclass and Pullout Settings

	Pullout		Inclass		
	Mean %	*SD*	Mean %	*SD*	*t* Value*
Instructional					
Giving Information	11.7	5.4	8.5	9.2	2.35
Giving Directions	7.3	5.0	2.9	5.5	4.43***
Questioning/Answering	10.4	10.9	5.3	8.4	2.85**
Reading to Students	4.6	6.8	1.9	4.0	2.51
Individual Contacts	5.1	6.8	10.8	13.6	−2.94**
Listening/Looking	21.2	9.6	10.2	11.0	5.77***
Indirect Interaction	14.9	11.5	17.0	14.2	−0.89
Feedback/Acknowledgement	2.9	4.5	0.5	1.7	3.72***
Total Instructional	78.1	9.2	57.1	13.2	10.04***
Noninstructional					
Transition	1.6	2.7	4.2	5.0	−3.51***
No Interaction	2.9	5.5	11.3	17.1	−3.69***
Behavior Management	0.9	1.6	0.6	2.2	0.90
Noninstructional Interaction	0.3	1.6	1.1	2.4	−2.14
Total Noninstructional	5.7	7.6	17.2	15.3	−5.22***
Scheduled Instruction Ceased	16.1	6.5	25.6	13.7	−4.93***
Out of Room	0.0	0.0	0.4	0.3	−1.00

$^{*}df = 117$. $^{**}p<.01$. $^{***}p<.001$.

setting spent 21.2% of remedial reading time involved in activities in which their teachers were listening to them or watching them work: for example, students had been given a workbook assignment and the teacher was observing a specific student at work; student was responding to teacher questioning. Students were also involved in indirect interaction activities 14.9% of the time (the target student being observed was part of a group being taught, but the teacher was focusing on the group rather than on the specific student). Students also received information 11.7% of the time (e.g., "This is how you divide words into syllables") and were involved in a questioning/answering dialogue with the teacher 10.4% of the time. Over 20% of the total student time in these pullout remedial settings was accounted for by: (a) no interaction (2.9%), (b) transition time (1.6%), and (c) scheduled instruction ceased (16.1%).

In the inclass remedial settings, students spent 57.1% of the time receiving instructional teacher attention, 17.2% in getting noninstructional teacher attention, and 25.6% when scheduled instruction had ceased. Most of the instructional time was focused on indirect interaction activities (17.0%), that is, the target student was part of a group with whom the teacher was working but at the time of observation, the teacher was not directing instruction specifically to the child being observed. Students also spent approximately 10% of their time in individual contacts with the teacher (teacher helping child with worksheet) or in listening/looking activities (teacher watching the child work or listening to the child respond). The greatest percentage of noninstructional time for students was in having no interaction with the teacher (11.3%), that is, the teacher was directly attending elsewhere. The combination of no interaction, transition (4.2%) and time coded as scheduled instruction ceased (25.6%) accounted for 41.1% of the total remedial time spent in the inclass setting.

There was a significant difference between settings in the percent of time students experienced teacher instructional behaviors, with more time spent in instruction in the pullout setting [$t(117)=10.04$, $p<.001$]. More specifically, significantly more student time in the pullout settings was spent on receiving directions, listening/looking interactions, and feedback acknowledgement (although little feedback was experienced by students in either setting).

There were also significant differences between the two settings in the total percent of time coded as noninstructional [$t(117)=5.22$, $p<.001$]. There was significantly more time spent in remedial inclass settings in transition and in *no interaction*, as well as in the total noninstructional time and in time coded as scheduled instruction ceased. The data do indicate greater variability in the inclass settings than in the pullout settings across several dimensions (e.g., no interaction, individual contacts).

Lesson

In this area, three different aspects of the lesson were addressed: the lesson focus, the type of material used, and the level of that material (word, sentence, or selection) (see Table 3).

Lesson focus. In the remedial pullout setting, students spent 50% of their time in skill-related lessons, 20.2% of their time engaged with text, and 7.1% of their time working independently. Skills emphasized were comprehension (15.8%), word identification (10.3%), and study skills (9.8%). Most text-related activities occurred *during* reading activities (15.2%).

In the remedial inclass setting, students spent most of their time (39.4%) in skill-related activities, 20.8% of the time in text-related activities, and 8.4% in independent activities. During skill-related activities, students spent the greatest percentage of time in study skills/testtaking activities (11.7%) and in word identification activities (10.4%). Students' time when working with text was spent in *after* reading activities (9.7%) or in *during* reading activities (7.0%).

There were no significant differences between pullout and inclass remedial settings in the percent of time that students spent on text-related work, although

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Table 3

Percentage of Remedial Time Students Spent on Aspects of Lesson Focus in Remedial Inclass and Pullout Settings

	Pullout		Inclass		
Lesson Focus	Mean %	*SD*	Mean %	*SD*	*t* Value*
No Focus	1.4	3.3	2.3	4.2	−1.35
Text Related					
Before Reading	1.7	2.8	1.9	4.9	−0.28
During Reading	15.2	14.2	7.0	12.1	3.39***
After Reading	2.9	4.8	9.7	12.0	−4.14***
Rereading	0.1	0.4	1.6	4.9	−2.56
Other	0.3	1.2	0.6	2.0	0.97
Total Text Related	20.2	16.8	20.8	22.2	−0.16
Skill Related					
Word Identification	10.3	11.4	10.4	12.9	−0.07
Vocabulary	5.8	7.7	5.7	8.5	0.04
Comprehension	15.8	14.5	7.8	8.3	3.58***
Study Skills/Testtaking	9.8	14.6	11.7	18.1	−0.60
Spelling/Grammar	1.7	3.4	1.9	5.4	−0.21
Composing	5.7	10.4	1.8	5.1	2.48
Speaking/Listening	0.9	1.7	0.0	0.0	3.68***
Total Skill Related	50.0	14.4	39.4	19.9	3.24**
Independent Work	7.1	9.9	8.4	10.1	−0.71
Scheduled Instruction Ceased	20.0	5.9	28.7	13.9	−4.53***
Out of Room	1.4	6.0	0.5	2.3	1.03

**df*=117. **$p<.01$. ***$p<.001$.

there were significant differences in how time was distributed within the various dimensions of that category. Students in the pullout remedial setting spent significantly more time in *during* reading activities [$t(117)=3.39$, $p<.001$], whereas students in the inclass setting spent significantly more time in *after* reading activities [$t(117)=-4.14$, $p<.001$].

Significantly more time was spent in remedial pullout settings on comprehension skills [$t(117)=3.58$, $p<.001$] and speaking/listening skills (although less than 1% of the weekly time was spent on this skill in the pullout setting). The data again indicate greater variability in student experiences in the remedial inclass setting.

Types of materials. In the remedial pullout setting, students spent most of their time with workbooks/worksheets (34.3%) and tradebooks (13.0%) (see Table 4).

Table 4

Percentage of Time Students Spent with Various Types of Materials in Remedial Inclass and Pullout Settings

	Pullout		Inclass		
Material	Mean %	*SD*	Mean %	*SD*	t Value*
Basal	5.5	10.9	20.5	20.8	−5.01***
Tradebook	13.0	14.8	0.3	2.4	6.16***
Content Text	1.4	4.2	0.6	4.2	0.96
Student Writing	6.8	8.7	1.5	4.2	4.01***
Chalkboard/Charts	5.0	10.3	1.3	3.7	2.53
Visuals/Tapes	0.2	1.1	0.0	0.0	1.42
Workbook/Worksheets	34.3	17.2	35.6	22.3	−0.37
Games/Flashcards	5.6	8.9	1.8	4.5	2.78***
No Materials	2.1	4.3	2.2	4.2	−0.13
Other	5.0	8.2	7.0	10.7	−1.08
Scheduled Instruction Ceased	20.0	5.9	28.7	13.8	−4.57***
Out of Room	1.3	6.0	0.5	2.4	0.90

*$df = 117$. **$p<.01$. ***$p<.001$.

In the inclass remedial setting, students also spent most of their time with workbooks or worksheets (35.6%) but also used basal materials (20.5%).

The key differences were that students spent a significantly greater percentage of time in the remedial pullout setting with tradebooks [$t(117)=6.16$, $p<.001$], student compositions [$t(117)=4.01$, $p<.001$], and games and flashcards [$t(117)=2.78$, $p<.001$], whereas students in the remedial inclass setting spent a significantly greater percentage of time with the basal reader [$t(117)=5.01$, $p<.001$].

Levels of text. In the remedial pullout setting, students spent more time with materials at the selection level (31.6%) than with materials focusing at the word level (23.0%) (see Table 5). Students in the remedial inclass setting spent more time with materials at the word level (28.9%) than with materials at the selection level (22.6%). There were no significant differences between settings on the percent of time students spent with different levels of text.

Student Behaviors

The three reading-related behaviors in which students spent most of their time in remedial pullout settings were listening (27.6%), silent reading (17.9%), or transcribing (16.7%) (see Table 6). The three reading-related behaviors that accounted for most of the students' time in the inclass remedial setting were also

Table 5

Percentage of Time Students Spent with Various Levels of Text in Remedial Inclass and Pullout Settings

	Pullout		Inclass		
Level of Text	Mean %	*SD*	Mean %	*SD*	*t* Value*
Word Level	23.0	20.5	28.9	17.8	−1.67
Sentence/Paragraph	19.3	16.0	16.6	16.2	0.92
Selection	31.6	19.9	22.6	20.1	2.44
Not Applicable	4.5	7.4	2.7	4.8	1.53
Scheduled Instruction Ceased	20.0	5.9	28.7	13.9	−4.54***
Out of Room	1.5	6.1	0.5	2.3	1.11

*$df = 117$. **$p < .01$. ***$p < .001$.

listening (38.5%), transcribing (12.9%), and silent reading (8.6%). Figure 1 illustrates graphically that these three activities accounted for over 60% of the students' time in both settings. In the pullout setting the time was somewhat evenly distributed among the three.

Little time was spent in either setting on oral reading activities, nor was much time spent in composing, although more composing was found in the pullout setting. Students in the remedial pullout setting spent a greater percentage of time in silent reading than did students in the remedial inclass setting (17.9% vs. 8.6%), whereas students in the inclass setting spent a greater percent of time listening than did students in the pullout setting (38.5% vs. 27.6%). There was also a greater percent of time spent in the inclass setting on volunteering to respond (3.5% vs. 1.4%).

DISCUSSION

Although prior research has indicated that setting itself is not a factor in program effectiveness or student achievement (Archambault, 1986; Leinhardt & Pallay, 1982), setting did seem to have an effect on the nature of the instruction experienced by students in this study. Although there were clearly some similarities in the nature of the remedial instruction experienced by students in the two settings, there were also some striking differences.

Similarities in Inclass and Pullout Settings

One of the most frequently experienced activities in both settings was for students to receive instruction from the teacher as part of a group (indirect interac-

Table 6

Percentage of Time Students Exhibited Various Reading-Related Behaviors in Remedial Inclass and Pullout Settings

	Pullout		Inclass		
Reading-Related Behaviors	Mean %	*SD*	Mean %	*SD*	t Value*
Silent Reading	17.9	17.9	8.6	17.0	2.86**
Oral Reading	6.5	6.2	3.9	7.6	2.00
Composing	4.0	9.0	0.6	2.4	2.66**
Transcribing	16.7	11.1	12.9	13.4	1.66
Listening	27.6	18.3	38.5	21.4	−2.92**
Talking	6.8	6.0	5.4	8.6	1.04
Off Task	2.8	4.4	2.8	5.0	−0.01
Volunteering	3.5	4.7	1.4	4.1	2.64**
Waiting	3.6	4.8	5.5	8.5	−1.58
Scheduled Instruction Ceased	8.8	8.2	19.7	12.7	−5.61***
Out of Room	1.8	6.5	0.6	2.4	1.25

$^{*}df = 117$. $^{**}p < .01$. $^{***}p < .001$.

tion). Moreover, in both settings there was a large percent of time in which students were not involved in any instructional activities. In neither setting were students involved in many behaviors that required management activities on the part of teachers. Neither group of students received much feedback or acknowledgement, nor were students read to frequently.

In terms of lesson focus, students in both settings experienced relatively more time on skill-related tasks than on text-related activities. In both settings, a small amount of time was spent in independent activities, generally with students completing workbook or worksheet assignments. This finding is different from that of others (Anderson, Cook, Pellicer, & Spradling, 1989; Office of Educational Research and Improvement, 1987) who indicate that often students in remedial settings spend a great deal of time working alone on independent assignments.

Instruction in both settings was distributed across materials at levels of the word, sentence/paragraph, and selection. In neither setting was much time spent in prereading activities. In both settings, a similar percent of time was spent in word identification activities, vocabulary, and study skills or test-taking activities.

Students in both settings spent the greatest percent of their time listening; and, in both settings students experienced similar amounts of time in transcribing or copying activities. In neither setting did students spend much time in composing or in oral reading activities, nor was much time spent in off-task behavior, waiting, or volunteering.

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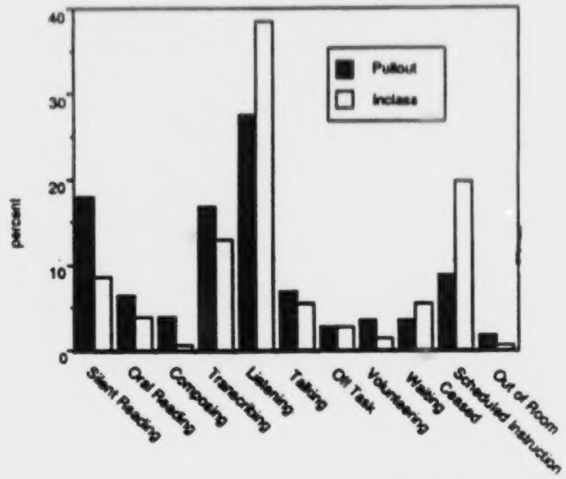

Figure 1. Percent of Weekly Time Students Exhibited Various Reading-Related Behaviors in Remedial Inclass and Pullout Settings

Distinctive Features of the Pullout Setting

The data from the pullout settings in this study in many ways confirm descriptions of others who have studied compensatory programs (Allington, 1986; Allington & McGill-Franzen, 1988; Archambault, 1986). A focus on skill instruction was predominant, although the impact of the recent research in reading which calls for more text-related activities could be seen in the use of tradebooks and student writing. There was relatively little time spent in activities prior to reading or after reading as compared to time during reading, however. This distribution of time does not reflect the current research which indicates a need for students to participate in prediction (Hansen, 1981; Olshavsky, 1976–77) or elaboration activities (Hidi & Anderson, 1986; Linden & Wittrock, 1981; Morrow, 1985). Moreover, the large percentage of time spent on listening as compared to reading, composing, or even discussion (talking) activities raises some questions about the appropriateness of these emphases in remedial classes for intermediate aged students.

In general, the materials and selection of skills seemed unrelated to the reading instruction received in the regular classroom; reading specialists in the pullout programs tended to use supplemental materials and not the basal used in the developmental reading program. In all pullout classes, instruction was implemented with the group as a whole. Thus, although these students may have been placed in a smaller group (size ranged from 2–5) than their classroom reading group, there were few occasions where specialists individualized instruction for students within the group. Moreover, often the reading specialists taught the same lesson to all groups of students they saw on a specific day or within a particular week. For example, during one week observers saw the same comprehension lesson, in which the goal was to help students become more familiar with story mapping as a means of enhancing comprehension, taught by one teacher with five different groups of students in five different classes. The same selection and worksheets were used with all classes. Although the goal of the lesson was a reasonable one for intermediate aged students, there is some question about the appropriateness of using the same selection with all of the students, across groups as well as within groups.

Distinctive Features of the Inclass Setting

In the inclass setting, individual students could frequently be found working with the reading specialist who functioned in a monitoring or tutoring mode. There were also greater amounts of time in which scheduled instruction had ceased or when there was no interaction between the reading specialist and students. A little more than a third of the instructional time was spent on skill-related activities, with the major emphasis on study skills or testing activities via workbooks or worksheets. Students spent time with text, mostly the basal text, and most of the focus was on *after* reading activities. The greatest proportion of time was spent with materials at the word level. Students spent at least a third of their time listening, followed by transcribing and then silent reading.

The frequent experiences of students with basal materials was an expected finding in the remedial inclass setting since one of the reasons for moving to this model of Chapter I service was to promote congruence between the remedial and developmental programs. Moreover, the finding that students had more individual contacts with teachers was also expected, given that the reading specialists began working with students after the developmental teachers had completed their group lessons. Thus, reading specialists in inclass settings often functioned as a monitor as students attempted to complete an assignment. However, the large amount of time in which students were not actually working (scheduled instruction ceased, no interaction, transition) was not expected; nor was the finding that students spent a large percentage of remedial reading time on skill work in workbooks or with worksheets. Also, the great variability in the experiences of students in the inclass setting speaks to the differences in how this instructional program was implemented across classrooms.

As mentioned previously, much of the instruction received by students in these inclass remedial settings was focused on the basal materials that were used as part of the developmental or classroom reading program. In some instances, observers noted that these Chapter I students experienced a great deal of difficulty reading the basal textbook, but given the nature of the program, the reading specialists continued to work with these materials, even though students may have been working at a high error rate. The reading specialist, in those instances, tended to give more support by providing additional clues to help students complete assignments correctly.

The nature of instruction experienced by students in these inclass settings reflected a change in role for the reading specialist. The greater percentage of time spent with the basal was an attempt to provide the congruence designated as important for students receiving instruction from two teachers (Allington, 1986; Johnston et al., 1985). Moreover, the reading specialists in these inclass settings tended to serve in the role of tutor or monitor, reinforcing the efforts of the classroom teacher, and serving in what Fraatz (1987) calls a supportive role. The variability in all three dimensions studied (teacher behaviors, lesson, and student behaviors) reflected the attempts of these reading specialists in the inclass programs to find their own way and to develop their own style of working in the same classroom as the student's developmental reading teacher.

One final point relates to the amount of time spent in remedial reading. Students in the inclass setting received an average of 310 minutes a week of classroom reading instruction and 50 minutes a week of remedial instruction (360 minutes of total reading instruction with 50 minutes of it taught by a reading specialist), whereas students in the pullout setting received reading from their classroom teacher an average of 360 minutes a week plus 100 minutes of remedial reading when they were pulled for Chapter I services from a subject other than reading. Thus, students in the inclass setting received less remedial reading time and less classroom reading time than did students in the pullout group.

Generalizability issues. This study was conducted in a large urban district with Chapter I options similar to those available in other urban districts across our nation. Although the inclass model, with its 20-minute observation time for the remedial reading teacher, may differ slightly from models used in other districts, the compensatory programs (inclass and pullout) in this study are representative of compenstory programs in other districts in several ways. First, in any inclass model, reading specialists have to accommodate to the scheduling and approaches of the developmental or classroom teacher. Second, inclass remedial reading teachers work with groups of students who have shared a common experience with their classroom teacher, while remedial reading teachers in a pullout setting generally work with students who come from several different classrooms and, therefore, may have had different instructional experiences. Third, the expectations of this district, relative to the compensatory reading program, address the goals and objectives expected for most Chapter I reading programs, that is, students should be provided with instruction that helps them improve their basic skills and instruction should focus on helping students achieve success in their classroom reading program.

Summary and Implications

Although significant differences were revealed on various dimensions of teacher behavior, lesson focus, and student behavior across settings, reading instruction was generally viewed in both models as a series of discrete skill or basal lessons culminating in assessment of mastery on identified skills. However, pullout and inclass settings created different roles for the reading specialist and somewhat different experiences for students. Moreover, the implementation of the inclass model was quite idiosyncratic in terms of how time would be spent; there was much more variability across the three dimensions in what students experienced in remedial reading. Finally, although the inclass model did not correct some of the perceived problems associated with pullout settings, students in inclass models used more congruent materials in their remedial reading programs. Further, they spent more, not less, time in transition than did students in pullout remedial settings. Although setting has yet to be established as a factor influencing achievement of students, setting as it was implemented in this district had an impact on how teachers organized lessons, on what students experienced, and on the behaviors of the students within that setting.

The movement across the country for greater integration of students into regular education programs speaks to the need for a new vision for compensatory programs. As school district personnel search for means by which they can achieve this vision, the solution of changing setting (from pullout to inclass) appears to be much more complex and perhaps less effective than one would hope. There are two points that need to be made regarding the findings of this study. First, setting can make a difference in terms of what students experience in compensatory education and that difference is not necessarily in the desired direction (e.g., increase in noninstructional time, focus on isolated skill practice). There is a continued need to study the nature of the instruction in both inclass and pullout settings. Specifically, researchers should move beyond the analysis of time allocated to various activities to an investigation of the nature of the instructional activities in a rich, qualitative manner (e.g., what were the explanations of the teachers in the instructional interactions? What *sorts* of activities were going on prior to reading? In what ways were students actively involved in the lesson?). Studies of instruction and explanation should be conducted in various compensatory education settings and at various levels of student ability/grade so that questions regarding the effects of these variables can be addressed.

Second, inclass models are not easy for remedial reading teachers to implement. The variability in the functioning of the reading specialists in this study speaks to their struggle to *fit* into the classroom regimen. Given the emphasis on integration and the movement to alternative models for compensatory programs, it is imperative that reading specialists be given training to help them function effectively. Moreover, questions regarding the appropriate role for the reading specialist need to be included in educational agendas. Although there is much enthusiasm for the "ideology of supportiveness" (Fraatz, 1987, p. 70) from those who believe that the strongest compensatory program is one that provides for congruence or alignment, there is still much to be learned about the appropriateness and effectiveness of this notion as well as how it can be best implemented in the total school reading program.

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Individual Differences in Reprocessing of Text

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This study examined the roles of basic reading processes and prior knowledge in reprocessing of expository text. According to their performance in a decoding and a working memory task, 48 college students were divided into groups of above-average and average readers and either rewrote notes, reread notes, or reread a text. The 3 strategies were equally effective in improving comprehension for text-explicit and text-implicit information, and reading ability and prior knowledge were more predictive for comprehension than was the type of reprocessing activity. Text reprocessing might help average readers to compensate for their lower performance in answering text-implicit questions, whereas above-average readers seem to combine more text information with their knowledge base. Working memory played the major role for comprehending text-implicit information, whereas knowledge was relatively more important for explicit and script-implicit information.

Reviews of note-taking research suggest that the process of taking notes does not globally facilitate comprehension and retention of discourse information (Hartley, 1983; Kiewra, 1985, 1989). Evidence demonstrating that note-taking improves recall of important lecture information (Einstein, Morris, & Smith, 1985), generation of connections between new information and prior knowledge (Peper & Mayer, 1986), and organization of coherent discourse representations (Cook & Mayer, 1983), supports the view that taking notes stimulates qualitatively different types of encoding activities rather than facilitating overall retention (Bretzing & Kulhavy, 1981; Hidi & Klaiman, 1983; Mayer, 1983; Smith & Tompkins, 1988).

The majority of studies, however, have concluded that the primary value of taking lecture notes is not to facilitate encoding but to improve comprehension by providing students with an external storage available for reprocessing (Carter & Van Matre, 1975; Ladas, 1980; Rickards & Friedman, 1978; Spires & Stone, 1989). These studies suggest that information is more likely to be remembered when the information is recorded in notes and reviewed.

Although there is considerable evidence demonstrating the importance of reviewing notes in learning from lectures, the relative effectiveness of different review techniques remains to be specified (Barnett, Di Vesta, & Rogozinski, 1981; Kiewra, 1983; Kiewra, DuBois, Christian, & McShane, 1988) and extended to the more limited research on reprocessing of written texts.

In investigating review effects on learning from expository text, Crewe (1969) found that reviewing a previously underlined text increased retention as compared with a no-review condition. More recently Kardash and Kroeker (1989) examined the comprehension performance of students who reviewed and revised their notes, varying the timing of the review period. Subjects who reviewed their notes prior to the test (2 days after acquisition) recalled more idea units than subjects who reviewed notes immediately after acquisition, subjects who reviewed notes 1 day after acquisition, subjects who did not review, and subjects who reviewed mentally prior to the test (2 days after acquisition). This effect was attenuated when cloze and application test measures were analyzed. Kardash and Kroeker (1989) suggested that reviewing notes prior to the time of testing facilitates comprehension when the test provides no retrieval cues, whereas the activity of review might not be beneficial when a test itself provides retrieval cues.

Although there is some evidence that students who take notes during reading recall more text information (Bretzing & Kulhavy, 1979; Shimmerlick & Nolan, 1976), studies comparing the effects of different study techniques on reading comprehension have found simpler activities, such as underlining or repeated reading, to be at least as effective as note-taking. For example, a study by Jonassen (1984) revealed that readers who were instructed to interrelate important ideas during note-taking recalled more information of structural importance on a delayed test in comparison with readers who took notes with no integrative instruction, readers who underlined important ideas, and readers who just read the text. Similarly, in his review of study strategy research, Anderson (1980) found only two studies that reported a rereading strategy inferior to either note-taking or underlining, whereas several studies revealed no comprehension difference between repetitive reading, note-taking, and underlining. An analysis of Arnold's (1942) data showed that a rereading strategy improved comprehension on immediate and delayed tests in comparison with note-taking, outlining, and summarizing (Anderson, 1980). Consistent with this result, Howe and Singer (1975) showed that students who reread unfamiliar texts performed better on immediate and delayed free recall than subjects who summarized or copied the texts verbally, and Kardash, Amlund, and Kulhavy (1984) found no significant differences in recall when subjects were required to follow either a rereading, a note-taking, or an underlining strategy, with processing time held constant across conditions.

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TEXT REPROCESSING

Recently, researchers have examined repetitive reading more closely as a text reprocessing strategy rather than as a control condition for other techniques such as note-taking (e.g., Dowhower, 1989). Consistent with earlier results reported by Rothkopf (1968), Amlund, Kardash, and Kulhavy (1986) found that subjects who read a text twice recalled significantly more information in comparison with subjects who read the text once or three times. In their attempt to qualify the effects of rereading on learning from expository text, Amlund et al. (1986) further suggested that rereading primarily facilitates retention of main ideas and that persistence of errors in recall increases with repeated reading. Including ability (average College Board Achievement Test scores) as an additional factor, Barnett and Seefeldt (1989) found that repeated reading increased factual retention for all students, whereas only high-ability students improved their performance on a transfer task after a second reading trial. This result suggests that the effectiveness of different reprocessing strategies for comprehension are partly determined by individual differences in information-processing abilities.

As Kiewra (1989) has pointed out, only a few studies have investigated the ways in which cognitive differences among learners affect note-taking during lectures, and the role of such differences in taking notes from written texts and review activities has been essentially ignored. Earlier studies (Berliner, 1969; Di Vesta & Gray, 1973) showed that only those subjects with a greater ability to hold digit strings in working memory profited from note-taking, whereas note-taking interfered with comprehension for subjects who were low in working memory capacity. Extending these results, Kiewra and Benton (1988) found that subjects more able to hold and manipulate discourse information in working memory recorded more words, complex propositions, and main ideas than did subjects with lower ability. As these factors were positively related to lecture comprehension, this result indicates that subjects high in working memory capacity profited more from taking notes.

Other studies focusing on individual differences have found prior knowledge to affect note-taking behavior. For example, Peper and Mayer (1978, 1986) demonstrated that notetakers who were low in prior knowledge about the lecture topic performed better on problem-solving tasks and worse on factual retention and recognition tasks, whereas taking notes did not improve problem-solving performance for students with adequate prior knowledge. Peper and Mayer (1978, 1986) suggested that note-taking is most likely to facilitate encoding of information that is low in familiarity.

In summary, there is some evidence showing that taking notes during reading may improve recall of text information, but the primary value of notes seems to be their availability for review prior to comprehension tests. On the other hand, the activity of rereading text has been found to be as beneficial to comprehension as taking or reviewing notes. Other results also suggest that individual differences in cognitive processing may affect reprocessing behavior, but there has been little effort to systematically examine the relative effects of reading comprehension components on different reprocessing strategies of text.

In this study, we investigate decoding ability, working memory, and domain-specific prior knowledge as predictors of reading comprehension after either rewriting notes, rereading notes, or rereading a text. Through this investigation we attempt to specify the relative contributions of reading components to different reprocessing activities.

The study is based on a framework of reading comprehension that combines an information-processing account with a schema-based or knowledge-based account. According to this view, which was developed by Perfetti (1988, 1989), comprehension is determined primarily by the efficiency with which persons use local language processes such as word identification and encoding of propositions in working memory (Daneman & Carpenter, 1980; Kintsch & Van Dijk, 1978; Lesgold, Roth, & Curtis, 1979). To the extent that word decoding is resource demanding, assembly and integration of propositions in working memory are less efficient. As a consequence, the quality of temporarily constructed text representations suffers and affects, along with a reader's knowledge base, the construction of a text model (Anderson, Spiro, & Anderson, 1978; Johnson-Laird, 1983; Just & Carpenter, 1987; van Dijk & Kintsch, 1983).

A convergence of results from studies investigating reading comprehension within an information-processing framework has found general language comprehension processes, measured by listening comprehension (Palmer, MacLeod, Hunt, & Davidson, 1985), word decoding (Frederiksen, 1982; Oakhill & Garnham, 1988), and working memory constraints (Baddeley, Logie, Nimmo-Smith, & Brereton, 1985; Cunningham, Stanovich, & Wilson, 1990; Goldman, Hogaboam, Bell, & Perfetti, 1980; Rapala & Brady, 1990) to contribute independently to reading comprehension. Consistent with a schema-based theory of reading comprehension (Wilson & Anderson, 1986), there is ample evidence demonstrating the benefits of a reader's prior knowledge source on memory and comprehension (Anderson & Acker, 1984; Afflerbach, 1990; Reutzel & Morgan, 1990; Spilich, Vesonder, Chiesi, & Voss, 1979).

Recent studies including analysis of prior knowledge, as well as tests of reading comprehension ability, suggest that specific knowledge allows poor readers to compensate for their generally low comprehension ability in a familiar text domain (Adams, Bell, & Perfetti, 1990; Recht & Leslie, 1988; Yekovich, Walker, Ogle, & Thompson, 1990). In a previous attempt to examine the relative contributions of specific information-processing correlates of reading and prior knowledge to college-level reading comprehension, Haenggi and Perfetti (1991) identified word and pseudoword decoding, working memory, and knowledge as significant predictors of expository text comprehension. Furthermore, prior knowledge was more important for comprehension of information stated explicitly in the text, whereas working memory capacity made a larger contribution to comprehending information that had to be inferred from the text.

To specify the role of individual differences in reprocessing of text, we take into account the relative contributions of basic reading processes and knowledge to comprehension. Given the facilitating effects of different reprocessing strategies on reading comprehension, we expected that either rewriting notes, rereading notes, or rereading a text would generally improve comprehension. Assuming the crucial roles of prior knowledge and basic reading processes in comprehension, we also expected large roles for knowledge, decoding, and working memory. Determining the relative effectiveness of specific reprocessing activities and individual differences in reading ability, as well as in prior knowledge, should provide a further qualification of students' reading comprehension behavior, which is a prerequisite to improving instruction.

Method

Subjects

Forty-eight university undergraduates fulfilling a course requirement served as subjects. We used a median split to divide subjects into above-average and average readers on the basis of a composite score of reading ability. This measure combines reading speed with accuracy parameters and is an extension of a reading-efficiency measure proposed by Jackson and McClelland (1979). A measure of reading ability was calculated by multiplying the percentage of correctly recalled target words by the number of syllables read per minute in a probe discourse task and dividing this product by average vocalization speed for words and pseudowords. The mean reading scores (range = 60 to 427) for above-average and average readers, respectively, were 245 ($SD = 58$) and 105 ($SD = 33$), and subjects in the three reprocessing conditions were matched according to their reading ability scores. Because of the multiplicative measurement of reading ability, some above-average readers might have scored higher because they sacrificed word-recall accuracy for reading speed. However, three separate analyses of variance on the recall and raw reading-speed data showed that above-average readers recalled more words in the probe discourse task ($M = 62.7\%$, $SD = 10\%$) than average readers ($M = 56.2\%$, $SD = 8.6\%$), $F(1, 46) = 23.12$, $p < .001$. In addition above-average readers showed shorter reading times for sentences in the probe discourse task ($M = 252$ syllables per min, $SD = 55$), $F(1, 46) = 35.01$, $p < .001$, and shorter vocalization latencies in the decoding task ($M = 643$ ms, $SD = 65$ ms), $F(1, 46) = 13.69$, $p < .001$. In comparison, average readers read 162 syllables per min ($SD = 50$) in the probe discourse task and vocalized words and pseudowords with a mean latency of 774 msec ($SD = 160$ msec).

Design

Reading ability was used as an independent grouping variable. As a second factor, reprocessing type (rewrite notes vs. reread notes vs. reread text) was varied among subjects. Learning trial (processing the text in Session 1 vs. Reprocessing the text in Session 2) and question type (text-explicit vs. text-implicit vs. script-implicit) served as within-subject factors. The design was a 2 (reading ability) × 3 (reprocessing type) × 2 (learning trial) × 3 (question type) analysis of variance, with repeated measures on the learning trial and question type factors. Prior knowledge was included as a covariate. Accuracy in responding to multiple-choice comprehension questions and sentence verifications, as well as verification latencies, were the dependent measures.

Materials and Procedure

The study was conducted in two sessions, the first lasting about 2 hr and the second lasting about 1 hr. Subjects were to perform individually the vocalization task, the probe-discourse task, and the prior knowledge test and to carry out the reading task, as well as a sentence-verification and a multiple-choice comprehension test. Subjects were told either to take notes during reading or to read the text without taking notes. One day later, subjects were asked to rewrite their notes, to reread their notes, or to reread the text. After the reprocessing trial, the subjects were asked to complete a second set of sentence-verification and multiple-choice tests. The vocalization, the probe-discourse, and the two sentence-verification tasks were implemented with Micro Experimental Laboratory (Schneider, 1988), and a personal computer (Toshiba T1600) was used to present the stimuli. Vocalization and probe-recall latencies were measured with a response box with voice key.

Word and pseudoword vocalization task. Subjects read and vocalized 40 high-frequency (>100 per million) words, 40 low-frequency (1–7 per million; Meier, 1978) words, and 40 pronounceable pseudowords. For each word type, there were 10 items of the following length categories: five-letter/one-syllable words, five-letter/two-syllable words, eight-letter/two-syllable words, and eight-letter/three-syllable words. We matched the initial phoneme across the three word types because this factor can have an influence on vocalization latency (Frederiksen & Kroll, 1976). Word type and length were the within-subject variables, and decoding speed of correct responses was the dependent variable.

The stimuli were presented on a computer screen, and between each trial a fixation dot was displayed. A first block of 80 words was presented first, followed by a second block of 40 pseudowords, and the four length categories were randomized within each block. Response latencies were measured from stimulus onset to onset of vocalization.

Probe-discourse task. We used a probe-recall procedure to assess availability of recently encoded discourse segments in working memory. Subjects were presented with a text (about human thinking) that was approximately 700 words in length and of graduate level (Level 17) in readability (Fry, 1977). Single words from the text segment just read reappeared as probes, and subjects were asked to recall the target word that had followed a specific probe. The text segments varied in length (probe distance) and in occurrence versus nonoccurrence of a sentence boundary. For short segments (near probes), 2 content words, or between 2 and 7 content and functional words, intervened between the initial occurrence of the probe word and the recall test. For long segments or far probes, the probe test occurred after 5 content words, or between 7 and 12 words total. In a current text segment, the probe occurred in the sentence being read at the time of the test. In a preceding text segment, probe words occurred in the sentence preceding the one being read at the time of probe recall. Probe distance and segment type were the within-subject variables, and response accuracy was the dependent variable of interest. Reading times for each line of text were additionally recorded. Each Probe Distance × Segment Type combination occurred eight times in the text.

Subjects silently read one line of text at a time from the screen. Pressing a button on the response box permitted the subject to obtain either the next line or a probe word. As soon as the subject vocalized the word that followed the probe in the preceding text segment, the probe was replaced with the next line of text.

The probe-discourse task was found to be more highly correlated with comprehension measures such as the Davis Reading Test (Davis & Davis, 1962), $r = .68$, and the Jackson and McClelland (1979) reading comprehension test, $r = .78$, than was the Daneman and Carpenter (1980) reading span task, $rs = .49$ and $.53$ (Hammond, 1987). These data indicate that the probe-discourse task might measure components that are more similar to those involved in reading comprehension than those involved in the more frequently used reading span task.

Prior knowledge test. Twenty open-ended questions covered basic concepts in human problem-solving and decision-making theories.

Subjects were allocated 20 min to respond to short-answer information (e.g., "How can you support a decision-making process?"); the number of correctly answered questions was registered.

Reading task. Subjects were presented with a text 8 pages in length describing three different approaches to explaining human decision making (i.e., normative rules, heuristics, and problem-solving approach). The construction of the text was based on Huber (1982). A content analysis divided the text into 41 thematic blocks, or macropropositions (Meyer, 1985), and these were subdivided into 230 smaller idea units. This analysis served as a guideline for constructing sentence-verification and multiple-choice comprehension tests. Subjects were instructed to read the text while either taking notes or not taking notes. In either case students were informed that they would have to answer questions after the completion of the reading and that they would be given the opportunity to reprocess the text 1 day later.

Subjects were asked 24 hr later to rewrite their notes, to reread the notes, or to reread the text. The text was available for all subjects during reprocessing. The two note-taking groups were instructed to focus on their notes during reprocessing; post-experimental questioning confirmed that no subject in these groups simply reread the text. To hold learning time constant across the three reprocessing groups, original processing time, as well as reprocessing time, was recorded for those 16 subjects who rewrote their notes. Subjects who were asked either to reread their notes or to reread the text were matched according to these processing times. As a result of this yoking procedure, each experimental group spent an average of 38 min ($SD = 4.7$ min) processing the text on the first trial and 35 min ($SD = 4.3$ min) reprocessing the text.

Reading comprehension tests. After each text-processing trial, subjects were confronted with two different versions of a sentence-verification and a multiple-choice comprehension test. We based the construction of these tests on 80 statements that were either explicit or implicit with respect to information covered by the text. Forty explicit statements covered information directly stated in one sentence of the text. Forty implicit statements required the reader either to combine information from two sentences that appeared separated in the text or to draw inferences from his or her prior knowledge base. These categories are referred to as text-implicit and script-implicit statements (Pearson & Johnson, 1978), respectively, and both were represented by 20 items. With an interrater agreement of 95%, two independent raters allocated the 80 statements to the three defined categories before the items were split into two sets of 40 statements. Then we constructed sentence-verification and multiple-choice test versions for each set. After completing the first processing trial on the text, subjects received one version of a sentence-verification test and a multiple-choice test; the other version of the corresponding tests was completed following the reprocessing trial. Thus, subjects were presented with each test item in two different modes (sentence verification or multiple choice), and the presentation order of test versions was randomized across the three reprocessing conditions.

After reading the text, all subjects were shown 40 statements to which they were to respond true or false as rapidly as possible. To control for information quantity, an average length of 104 words per sentence was held constant across the explicit, text-implicit, and script-implicit sentence types. One half of the statements were false and the other half were true. The dependent measures were verification time and accuracy. Each sentence was presented in random order on the computer screen, and subjects used the index and middle fingers of their preferred hand to press the assigned "yes" or "no" keys. The verification task was followed by 40 multiple-choice questions. Items were randomized, and presentation order was the same for all subjects. The procedure for measuring comprehension was the same after the reprocessing trial, except that subjects received multiple-choice questions from Session 1 as sentence verifications and vice versa.

Results

As was pointed out, the decoding and working memory tasks were used to form a composite measure of reading ability (see the Appendix for individual analyses of variance of these tasks). For subjects who rewrote or reread their notes, an analysis showed that the two reader groups did not differ in the quantity of notes taken. Above-average readers did not take significantly more notes ($M = 53$ idea units, $SD = 13$) than average readers ($M = 49$ idea units, $SD = 13$), $|t| < 1$, when they read the text the first time. Rewritten notes contained an average number of 50 idea units ($SD = 14$) for above-average readers and 48 idea units ($SD = 19$) for average readers, $|t| < 1$. An analysis of note-taking quality focused on the occurrence of elaborative processes (e.g., inferences, generalizations of idea units) in notes. The mean frequency of elaborations was generally low (< 1), indicating that readers took primarily verbatim notes.

To examine the effects of the three reprocessing conditions on comprehension relative to reading ability and prior knowledge, we first report analyses of variance. Then, to investigate the relative contributions to reading comprehension of decoding speed, working memory accuracy, and knowledge, we report the results of correlations and stepwise regressions.

Reprocessing Effects Relative to Reading Ability and Prior Knowledge

First, the results were analyzed by performing three separate $2 \times 3 \times 2 \times 3$ analyses of covariance, one with multiple-choice test accuracy as the dependent variable, one with sentence-verification accuracy as the dependent measure, and one with sentence-verification latencies as the dependent variable. In each analysis, reading ability (above-average vs. average) and reprocessing type (rewrite notes vs. reread notes vs. reread text) were between-subjects factors, whereas learning trial (1 vs. 2) and question type (explicit vs. text-implicit vs. script-implicit) served as within-subject factors. Furthermore, we included prior knowledge as a covariate for all between-subjects analyses. The significance level was fixed at an alpha of .05.

A learning trial effect, $F(1, 42) = 39.05$, $p < .001$, revealed a higher portion of correct multiple-choice answers after a reprocessing trial ($M = 66\%$, $SD = 15\%$) than after a first learning trial ($M = 59\%$, $SD = 16\%$).

A question type effect, $F(2, 84) = 152.32$, $p < .001$, indicated a higher response accuracy for explicit questions ($M = 73\%$, $SD = 11\%$) in comparison with text-implicit questions ($M = 57\%$, $SD = 11\%$), $t(84) = 11.17$, $p < .001$, and script-implicit questions ($M = 48\%$, $SD = 11\%$) were answered less accurately than text-implicit questions, $t(84) = 6.28$, $p < .001$.

Above-average readers answered more multiple-choice questions correctly ($M = 66\%$, $SD = 16\%$) than average readers ($M = 59\%$, $SD = 14\%$), $F(1, 41) = 6.55$, $p < .02$. Table 1 includes the mean multiple-choice accuracies for the two reader groups.

Table 1
Mean Percentages and Standard Deviations of Correctly Answered Explicit (Exp), Text-Implicit (T-Imp) and Script-Implicit (S-Imp) Multiple-Choice Questions for Above-Average and Average Readers on Learning Trials I and II in Three Reprocessing Conditions

	Learning Trial I						Learning Trial II					
	Exp		T-Imp		S-Imp		Exp		T-Imp		S-Imp	
Group/ reprocessing condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Above-average readers												
Rewrite notes	76	12	56	17	52	9	84	11	64	15	53	10
Reread notes	68	14	56	13	46	13	83	11	58	13	53	15
Reread text	71	6	58	7	51	12	81	10	68	12	56	9
Average readers												
Rewrite notes	64	7	49	8	45	9	64	11	59	16	41	8
Reread notes	66	13	49	8	46	13	77	8	63	13	46	14
Reread text	65	13	45	15	45	8	74	13	61	14	43	17

Note. Values are given in percentages.

Reprocessing type did not affect multiple-choice accuracy, $F < 1$, but prior knowledge made a significant contribution, $F(1, 41) = 24.64$, $p < .001$. Learning trial interacted with question type, $F(2, 84) = 10.77$, $p < .001$, indicating that explicit questions were answered more accurately after the second learning trial ($M = 77\%$, $SD = 12\%$) than after the first learning trial ($M = 68\%$, $SD = 11\%$), $t(84) = 8.49$, $p < .001$. Higher accuracy rates were shown for text-implicit questions when they were answered after reprocessing the text ($M = 62\%$, $SD = 13$) than when they were answered during the first trial ($M = 52\%$, $SD = 12\%$), $t(84) = 9.43$, $p < .001$. In contrast, script-implicit questions remained at the same accuracy level from the first trial ($M = 48\%$, $SD = 11\%$) to the second trial ($M = 48\%$, $SD = 13\%$), $|t| < 1$.

A Learning Trial × Question Type × Ability interaction, $F(2, 84) = 5.54$, $p = .005$, revealed the following group differences: Average readers showed relatively greater improvement from the first to the second learning trial on text-implicit questions, $t(84) = 3.51$, $p < .001$, whereas above-average readers showed relatively greater improvement on script-implicit questions, $t(84) = 2.65$, $p < .01$. Improvement scores for explicit questions were only marginally higher for above-average readers, $t(84) = 1.85$, $p < .10$. For these group comparisons, we used a covariate adjustment of the mean multiple-choice accuracy improvement scores. The adjusted scores for above-average readers were 10.7%, 6.1%, and 3.6% for explicit, text-implicit, and script-implicit questions, respectively. The corresponding improvement scores for average readers were 6.8%, 13.5%, and −2.0%.

A second four-factor analysis of covariance including prior knowledge as a covariate for the between-subjects effects was based on sentence-verification accuracy as a dependent variable. Sentences were correctly verified at a higher rate when the test was taken after reprocessing ($M = 70\%$, $SD = 12\%$) than after a first reading trial ($M = 61\%$, $SD = 11\%$), $F(1, 42) = 78.25$, $p < .001$.

A question type effect, $F(2, 84) = 40.11$, $p < .001$, reflected lower verification accuracies for text-implicit sentences ($M = 62\%$, $SD = 12\%$) than for explicit sentences ($M = 72\%$, $SD = 7\%$), $t(84) = 5.82$, $p < .001$, and text-implicit sentences were verified more accurately than were script-implicit sentences ($M = 57\%$, $SD = 12\%$), $t(84) = 2.91$, $p < .01$.

Above-average readers verified the sentences more accurately ($M = 70\%$, $SD = 11\%$) than did average readers ($M = 61\%$, $SD = 12\%$), $F(1, 41) = 20.56$, $p < .001$. Sentence-verification accuracy data for the two groups are summarized in Table 2. Verification accuracy was not dependent on reprocessing type, $F < 1$, and prior knowledge contributed again to comprehension performance, $F(1, 41) = 16.88$, $p < .001$.

A Learning Trial × Question Type interaction, $F(2, 84) = 3.77$, $p < .03$, indicated relatively less improvement from the first to the second learning trial on script-implicit sentences ($M = 5.1\%$, $SD = 14\%$) in comparison with both explicit sentences ($M = 9.0\%$, $SD = 9\%$), $t(84) = 2.32$, $p < .05$, and text-implicit sentences ($M = 11.8\%$, $SD = 12\%$), $t(84) = 4.06$, $p < .001$, whereas improvement scores on explicit and text-implicit sentences did not differ significantly, $t(84) = 1.62$, $p > .05$.

A third 2 × 3 × 2 × 3 analysis of covariance, which included sentence-verification times as dependent measures, revealed only two main effects. Sentences were verified faster after the second learning trial (6,841 msec, $SD = 1{,}409$ msec) than after the first learning trial (7,429 msec, $SD = 1{,}443$ msec), $F(1, 42) = 13.24$, $p < .001$.

A question type effect, $F(2, 84) = 79.97$, $p < .001$, indicated shorter verification times for explicit sentences (6,679 msec, $SD = 1{,}245$ msec) than for text-implicit sentences (7,231 msec, $SD = 1{,}390$ msec), $t(84) = 4.34$, $p < 0.001$, and response times were longer for script-implicit sentences (8,263 msec, $SD = 1{,}722$ msec) than for text-implicit sentences, $t(84) = 8.12$, $p < .001$.

Sentence-verification times did not significantly differentiate above-average readers ($M = 6{,}831$ msec, $SD = 1{,}127$ msec) from average readers (7,439 msec, $SD = 1{,}427$), $F(1, 41) = 1.61$, $p > 0.2$, and neither reprocessing type nor prior

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Table 2
Mean Percentages and Standard Deviations of Correctly Verified Explicit (Exp), Text-Implicit (T-Imp), and Script-Implicit (S-Imp) Sentences for Above-Average and Average Readers on Learning Trials I and II in Three Reprocessing Conditions

Group/	Learning Trial I						Learning Trial II					
	Exp		T-Imp		S-Imp		Exp		T-Imp		S-Imp	
reprocessing condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Above-average readers												
Rewrite notes	76	6	59	16	61	15	82	10	72	19	64	10
Reread notes	69	7	60	14	63	16	77	8	70	8	63	15
Reread text	69	7	63	9	58	15	79	6	79	10	64	7
Average readers												
Rewrite notes	64	7	46	13	49	10	69	5	61	11	50	12
Reread notes	63	6	55	5	49	18	81	11	69	15	56	14
Reread text	64	10	53	13	48	7	71	6	55	12	60	15

Note. Values are given in percentages.

knowledge affected verification times, both $Fs < 1$. The mean verification times for the two reader groups are displayed in Table 3.

Contributions of Decoding, Working Memory, and Prior Knowledge to Reading Comprehension

We examined the relative contributions of decoding, working memory, and prior knowledge to comprehension of explicit, text-implicit, and script-implicit information by stepwise regressions. On the basis of a framework of reading (Perfetti, 1988), we entered the measures according to their assumed processing complexity. To predict reading comprehension accuracy, as well as sentence-verification time, mean correct vocalization latencies for words and pseudowords, probe-recall accuracy, and prior knowledge were entered in three steps. To form a mean comprehension accuracy score, we combined multiple-choice and sentence-verification accuracies. These two measures were highly correlated for both above-average readers, $r = .84$, $df = 22$, $p < .001$, and average readers, $r = .78$, $df = 22$, $p < .001$.

Correlations between reading-comprehension accuracy and the three predictors are presented in Table 4. Probe-discourse accuracy was moderately related to comprehension performance for text-implicit and explicit information (with 46 *df*, $r > .30$ is significant at $p < .05$). Prior knowledge also was moderately related to accuracy scores for explicit and script-implicit questions. Furthermore, accuracy scores for explicit, text-implicit, and script-implicit questions that were taken after the first learning phase substantially correlated with the corresponding scores following a reprocessing trial ($rs = .73$, .77, and .66, respectively).

We performed three stepwise regressions using comprehension accuracy for each question type as a separate dependent variable. The results of these regressions are summarized in Table 5.

Entering the three predictors into a regression equation to predict comprehension performance for explicit questions, we found 67.3% of the variance explained. (Correcting for shrinkage produced an adjusted R^2 of .65). Table 5 shows that probe-discourse accuracy (35%, $p < .001$) and prior knowledge (28.3%, $p < .001$) accounted for significant proportions of variance in comprehension for explicit questions.

Table 3
Mean Response Times and Standard Deviations in Milliseconds for Explicit (Exp), Text-Implicit (T-Imp), and Script-Implicit (S-Imp) Sentence Verifications for Above-Average and Average Readers on Learning Trials I and II in Three Reprocessing Conditions

Group/	Learning Trial I						Learning Trial II					
	Exp		T-Imp		S-Imp		Exp		T-Imp		S-Imp	
reprocessing condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Above-average readers												
Rewrite notes	6,432	819	7,211	1,409	8,064	1,456	5,928	1,344	6,902	1,832	7,665	1,661
Reread notes	6,394	1,328	6,968	896	8,201	2,018	5,962	1,208	6,019	1,221	8,015	1,754
Reread text	6,991	1,285	7,307	1,211	8,201	1,618	6,489	1,317	6,945	1,096	8,023	1,493
Average readers												
Rewrite notes	6,778	1,001	7,383	1,069	8,252	1,067	6,945	1,684	7,309	2,002	8,102	1,999
Reread notes	8,031	1,716	8,518	1,738	9,093	1,905	6,568	587	7,195	690	8,688	1,088
Reread text	7,195	1,848	8,020	3,117	9,266	3,292	6,446	1,795	6,997	2,321	7,585	2,564

Note. Only correct responses are included.

Table 4
Correlations of Explicit (Exp), Text-Implicit (T-Imp), and Script-Implicit (S-Imp) Comprehension Accuracy Measures with Decoding Speed (Decoding), Probe Discourse Accuracy (Probe), and Prior Knowledge (Knowledge) for Learning Trials I and II

Measure	1	2	3	4	5	6	7	8	9
1. Decoding	—								
2. Probe	−.19	—							
3. Knowledge	−.10	.19	—						
4. Exp I	−.21	.59*	.61*	—					
5. T-Imp	−.04	.62*	.20	.52*	—				
6. S-Imp	−.23	.42*	.67*	.52*	.34*	—			
7. Exp II	−.16	.56*	.59*	.73*	.63*	.60*	—		
8. T-Imp II	−.04	.61*	.26	.59*	.77*	.23	.67*	—	
9. S-Imp II	−.05	.33*	.71*	.60*	.43*	.66*	.62*	.45*	—

Note. I = Learning Trial I; II = Learning Trial II.
* $p < .05$, two-tailed.

In predicting comprehension accuracy for text-implicit information, the working memory variable made the only significant contribution (43.8%, $p < .001$). The three predictors together explained 45.6% of the variance in comprehension (adjusted $R^2 = .418$).

When accuracy scores for answering script-implicit questions served as a dependent variable, probe-discourse accuracy contributed significantly to the variance explained (15.2%, $p < .01$), and prior knowledge made the largest contribution (47%, $p < .001$). The three predictor variables explained 64.4% of variance in comprehension performance for script-implicit questions (adjusted $R^2 = .620$).

A second correlational analysis (see Table 6) showed that verification times for all three question types correlated with word and pseudoword vocalization speed, whereas the time measures were not significantly related to probe discourse accuracy and prior knowledge. Verification times were also significantly related to each other on both learning trials, rs = .61, .40, and .71 for explicit, text-implicit, and script-implicit questions, respectively.

To examine wether decoding, working memory, and prior knowledge contributed to sentence-verification times, we performed another set of three stepwise regressions. Table 7 summarizes the results of these regressions.

When the three predictors were entered into a regression analysis to predict verification times for explicit sentences, 23.6% of the variance was explained (adjusted $R^2 = .184$). With a significant portion of 21.3% ($p < .001$), decoding speed accounted for most of the variance explained.

Table 7 shows the same pattern of results for the two remaining question types. With regard to text-implicit sentences, decoding accounted for 17.7% ($p < .001$) of the variance in verification time. The total percentage of variance explained was only 19.4% (adjusted $R^2 = .139$).

When verification time for script-implicit sentences was predicted, the decoding variable explained 17.5% ($p < 0.001$), and the three predictors accounted for 18.1% of variance (adjusted $R^2 = .125$).

Table 5
Summary of the Stepwise Prediction of Text Comprehension Performance for Explicit, Text-Implicit, and Script-Implicit Questions

Question type/ variable entered	R	R^2	Change in R^2	Change in F
Explicit				
1. Decoding speed	.199	.040	.040	1.89
2. Probe discourse accuracy	.624	.390	.350**	25.80
3. Domain-specific prior knowledge	.820	.673	.283**	38.06
Text-implicit				
1. Decoding speed	.045	.002	.002	0.09
2. Probe discourse accuracy	.663	.440	.438**	35.17
3. Domain-specific prior knowledge	.675	.456	.016	1.25
Script-implicit				
1. Decoding speed	.147	.022	.022	1.02
2. Probe discourse accuracy	.417	.174	.152*	8.27
3. Domain-specific prior knowledge	.802	.644	.470**	58.10

* $p < .01$. ** $p < .001$.

Discussion

Consistent with the hypothesis that the activity of reprocessing text generally facilitates reading comprehension, more multiple-choice questions and sentence verifications were answered correctly and sentences were verified faster after a reprocessing trial. This result adds to other demonstrations that the activity of review or reprocessing improves comprehension of both orally presented (e.g., Bromage & Mayer, 1986; Knight & McKelvie, 1986) and written texts (e.g., Kardash & Kroeker, 1989).

In comparison with earlier work in the field, different reprocessing activities in this study were systematically varied and related to individual differences in cognitive processing components of reading. We found that rewriting notes, rereading notes, and rereading the text were equally effective

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Table 6

Correlations of the Explicit (Exp), Text-Implicit (T-Imp), and Script-Implicit (S-Imp) Sentence Verification Times with Decoding Speed (Decoding), Probe Discourse Accuracy (Probe), and Prior Knowledge (Knowledge) for Learning Trials I and II

Measure	1	2	3	4	5	6	7	8	9
1. Decoding	—								
2. Probe	−.19	—							
3. Knowledge	−.10	.19	—						
4. Exp I	.48*	−.07	−.27	—					
5. T-Imp I	.34*	−.20	−.08	.68*	—				
6. S-Imp I	.44*	−.16	−.17	.80*	.64*	—			
7. Exp II	.35*	−.11	−.08	.61*	.48*	.66*	—		
8. T-Imp II	.37*	−.12	−.09	.57*	.40*	.62*	.84*	—	
9. S-Imp II	.33*	.08	.01	.62*	.61*	.71*	.82*	.70*	—

Note. I = Learning Trial I; II = Learning Trial II.
* $p < .05$, two-tailed.

activities for improving reading comprehension performance. With regard to the role of note-taking, subjects who took notes did not differ in comprehension, after a first learning trial, from subjects who only read the text. Moreover, subjects who simply reread the text performed as well on the second learning trial as subjects who reprocessed their notes, either by revision or rereading. The latter result extends earlier evidence showing repetitive reading to be an efficient reprocessing strategy (e.g., Amlund et al., 1986; Barnett & Seefeldt, 1989).

As was expected from a verbal efficiency view of reading, as well as from a schema-based view of reading, above-average readers showed higher comprehension accuracy scores than did average readers after both learning trials, and prior knowledge was positively related to reading comprehension. Combining two different theoretical assumptions, this result demonstrates large roles for basic reading processes and specific knowledge in reading comprehension that are relatively independent of the specific type of review activity.

Table 7

Summary of the Stepwise Prediction of Sentence Verification Times for Explicit, Text-Implicit, and Script-Implicit Questions

Question type/ variable entered	R	R^2	Change in R^2	Change in F
Explicit				
1. Decoding speed	.461	.213	.213*	12.43
2. Probe discourse accuracy	.461	.213	.000	0.02
3. Domain-specific prior knowledge	.485	.236	.023	1.30
Text-implicit				
1. Decoding speed	.420	.177	.177*	9.88
2. Probe discourse accuracy	.438	.192	.015	0.82
3. Domain-specific prior knowledge	.440	.194	.002	0.11
Script-implicit				
1. Decoding speed	.419	.175	.175*	9.78
2. Probe discourse accuracy	.422	.178	.003	0.16
3. Domain-specific prior knowledge	.426	.181	.003	0.15

* $p < .001$.

Several results in this study indicate more specific effects of text reprocessing on reading comprehension. For example, reprocessing facilitated comprehension of information that was both explicitly stated in the text and inferable from the text but did not facilitate comprehension for information that had to be inferred from a reader's prior knowledge base. This result suggests that the activity of reprocessing was used primarily to learn more about factual knowledge and the ways in which it can be interrelated, whereas students were less engaged in elaborating their already existing schemata during reprocessing. In this regard, it is interesting that verification times were longer for script-implicit sentences than for text-implicit sentences and that sentences that covered factual information explicitly stated in the text were verified even faster. This result suggests that implicit information requires more inferencing than explicit information and that when information has to be activated from the prior knowledge base, additional effort is indicated by increasing processing times.

An interaction of question type with reading ability indicated a further specification of reprocessing effects. Above-average readers showed relatively greater improvement from the first to the second learning trial on script-implicit multiple-choice questions. In contrast, average readers showed relatively greater improvement on text-implicit questions. This result indicates that text reprocessing helped average readers to learn more information that had to be inferred from the text, whereas above-average readers took the reprocessing trial as an opportunity to combine text information with their prior knowledge base.

When the dependent variable was more time-sensitive, as was the case for the sentence-verification task, average readers comprehended at a lower level, regardless of information type. It is interesting that the sentence-verification accuracy data showed a less homogeneous pattern for average readers, in-

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dicating that average readers who reread their notes answered as many sentences correctly as above-average readers when the sentences covered explicit or text-implicit information. One might speculate that rereading one's own notes helps less-skilled readers to improve comprehension, whereas skilled readers seem to be less affected by the type of reprocessing strategy applied. This hypothesis remains to be tested, and one way to do this might be to choose longer retention intervals and comprehension tests that provide fewer retrieval cues.

The availability of retrieval cues might also be the reason for the weak relation between the number of noted idea units and comprehension accuracy after a first learning trial ($r = 0.16$), as well as after reprocessing ($r = 0.24$). Studies that have reported stronger relations between the extensiveness of notes and comprehension of lecture information (e.g., Fisher & Harris, 1973; Kiewra & Fletcher, 1984) typically have used learning measures such as open-ended questions and free recall. In the present study, the cues provided by multiple-choice questions and sentence verifications were more specific.

Investigating the relative effects of reading components on reprocessing of text, we found probe-discourse accuracy to contribute significantly to comprehension. Knowledge also made a unique contribution to comprehension for explicit and script-implicit information and did not play a significant role when information had to be combined across the text. This result suggests that inference processes that are primarily text driven may be qualitatively different from inference processes that are knowledge driven. As others have suggested, knowledge-driven inferences are based on an automatic spreading activation process and are relatively effortless (Kintsch, 1988; Yekovich et al., 1990). In contrast, text-implicit inferences require the reader to maintain and combine several propositions in working memory, which is a relatively effortful activity and does not rely on prior knowledge. The ability to maintain discourse segments in working memory also seems to be a prerequisite to comprehending explicit and script-implicit information, and knowledge appears to support these comprehension processes.

In contrast to comprehension accuracy, working memory and prior knowledge did not contribute to sentence-verification times, whereas decoding speed was a significant predictor. The data indicate that decoding ability is related to comprehension speed measures that seem to be independent of accuracy measures.

In conclusion, rewriting notes, rereading notes, and rereading text were shown to be equally effective strategies for improving comprehension of explicit and text-implicit information, and individual differences in basic reading processes and prior knowledge contributed more to reading comprehension than did the specific reprocessing activity. The results further suggest that proficient readers seem to learn more factual information and relate it to their schemata during reprocessing, whereas reprocessing might help less proficient readers compensate for their lower performance when information has to be inferred from the text.

As cognitive differences among readers, such as working memory processing strategies and prior knowledge, are more thoroughly examined in text reprocessing, instructional techniques may be specified that improve comprehension relative to learner capabilities and relative to the type of information requested.

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Appendix

Analyses of the Decoding and Working-Memory Measures

Word and Pseudoword Vocalization Task

A word-type effect, $F(2, 94) = 98.30$, $p < 0.001$, revealed longer vocalization latencies for low-frequency (662 msec; $SD = 126$) compared to pseudowords (837 msec; $SD = 207$), $t(94) = 7.6$, $p < 0.001$, but the latencies were not significantly longer for low-frequency than for high-frequency words (626 msec; $SD = 97$), $t(94) = 1.56$, $p > 0.05$.

A word-length effect, $F(3, 141) = 53.31$, $p < 0.001$, indicated shorter vocalization latencies for two-syllable-five-letter (659 msec; $SD = 106$) than for two-syllable-eight-letter words (745 msec; $SD = 160$), $t(141) = 7.1$, $p < 0.001$, whereas three-syllable-eight-letter words were not significantly vocalized slower (754 msec; $SD = 176$) compared to two-syllable-eight-letter words, $|t| < 1$. Moreover, two-syllable-five-letter words were not vocalized slower (668; $SD = 109$) than one-syllable-five-letter words, $|t| < 1$.

Length interacted with word type, $F(6, 282) = 31.42$, $p < 0.001$, indicating that the difference between two-syllable-five-letter and two-syllable-eight-letter words was more pronounced for pseudowords (181 msec; $SD = 161$) compared to both high-frequency (33 msec; $SD = 47$), $t(94) = 11.28$, $p < 0.001$, and low-frequency words (49 msec; $SD = 54$), $t(94) = 10.08$, $p < 0.001$. These vocalization latency differences were not significantly greater for low-frequency than for high-frequency words, $t(94) = 1.22$, $p > .10$. The mean vocalization latencies for each word type and length category are displayed in Table A1.

Table A1
Mean Vocalization Latencies and Standard Deviations in Milliseconds for Words and Pseudowords Varying in Length

	Word length							
	5-1		5-2		8-2		8-3	
Frequency	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
High	606	82	606	92	640	107	656	124
Low	644	108	632	108	681	138	689	161
Pseudoword	758	155	745	143	926	283	928	284

Note. The first digit in word length categories indicates the number of letters, and the second digit indicates the number of syllables. Only correct responses ($M = 97.5\%$ correct, $SD = 1.8\%$) are included.

Table A2
Mean Percentages and Standard Deviations of Correctly Recalled Targets for Probes Varying in Distance and Segment Type

	Segment type			
	Current		Preceding	
Probe distance	*M*	*SD*	*M*	*SD*
Near	87%	13%	64%	17%
Far	38%	17%	36%	15%

Similar to data reported by Haenggi & Perfetti (1991), a word-length effect in decoding was indicated by a letter effect and vocalization time increased most from five- to eight-letter pseudowords.

Probe Discourse Task

Target words were better recalled for near (75.5%; $SD = 12.3$) than for far probes (37.1%; $SD = 14.5$), $F(1, 47) = 333.9$, $p < 0.001$, and targets were recalled at a higher rate when the probe occurred in a current text segment (62.6%; $SD = 11.3$) compared to probes from a preceding segment (50.1%; $SD = 13.5$), $F(1, 47) = 65.74$, $p < 0.001$.

A probe-distance by segment-type interaction, $F(1, 47) = 34.66$, $p < 0.001$, indicated that near targets were better recalled following a probe word in a current compared to a preceding text segment, $t(47) = 13.66$, $p < 0.001$, whereas recall accuracy did not significantly differ between the current and preceding segment types when probe distance was far, $t(47) = 1.18$, $p > 0.1$. The mean recall accuracy data for each probe distance and segment type are summarized in Table A2.

The probe memory data suggest that subjects could use the sentence boundary as a cue for recoding only when the discourse segment to be held in working memory was short enough. This result is consistent with earlier work by Goldman, Hogaboam, Bell, and Perfetti (1980).

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The Process of Understanding: Reading for Literary and Informative Purposes

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Abstract. This study was primarily concerned with the literary meaning-making experience. In all, 216 protocols were collected from 36 students (18 7th graders and 18 11th graders). Over several weeks, each student engaged in a series of think-aloud sessions during which each read two short stories, two poems, one science selection, and one social studies selection. All think-alouds were tape recorded and transcribed to permit qualitative analyses of students' language and thought as evidence of the process of interpretation.

Findings identify four recursive stances readers take in relation to the text, with each adding a somewhat different dimension to the understanding of the entire piece. They are: being out and stepping into an envisionment, being in and moving through an envisionment, stepping back and rethinking what one knows, and stepping out and objectifying the experience. In addition to using these stances, students' overall orientation toward literary meaning-building involved exploring a horizon of possibilities, while the reading of other material involved maintaining a point of reference. It was this distinction which seemed to underlie the different approaches to understanding the students called upon when reading for literary and informative purposes.

The decade of the 1980s has been marked by calls for increased attention to students' thinking and reasoning about what they are reading in all of their subjects, across the curriculum (Applebee, Langer, & Mullis, 1987, 1989, 1990; Boyer, 1983; Commission on Excellence in Education, 1983; National Governors' Conference, 1990). For English teachers, this has meant a focus on the reading of literature—calling it back to the center of concern after several decades of benign neglect.

Yet there is considerable disagreement about the role that literature should play in the K–12 curriculum. For many, the teaching of literature is often treated only as a way to introduce students to the cultural knowledge, the great thoughts, and the high culture of our society (Bloom,

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1987; Cheyney, 1987; Hirsch, 1987; Ravitch & Finn, 1987); its role in the development of the sharp and critical mind is often ignored. However, there is evidence from a number of sources that narrative thought is part of the well-developed intellect, and that it is important in contexts other than literature.

Putnam (1978) suggests that literary understanding, with its attention to how people live, is an important part of scientific thought, and that the imagination and sensibility that accompany literature are essential elements in scientific reasoning. Similarly, Dworkin (1983), in an article on law and literature, argues that the understanding of law can be enhanced by literary approaches to interpretation. Elstein, Shulman, and Sprafka (1978), in a study of ways in which doctors arrive at diagnoses, have shown that doctors who usually use "logic" to reach a diagnosis turn to "storytelling" in solving difficult problems; narrative thought is a productive alternative for them. Orr (1987a, 1987b) studied the ways in which technicians who repair highly complex machines go about building their understanding of the problem. He similarly reports that stories are remembered and told during the diagnosis of the problem, and that notions of the repairers' expertise grow out of their ability to engage in and abstract information from narratives. Generalizing across fields of inquiry, Bruner (1986) argues that there are two modes of cognition—narrative and paradigmatic—each with its own way of viewing reality. Full understanding, he suggests, is better achieved by using both the ordered thought of the scientist and the humanely inquisitive thought of the storyteller. The paradigmatic mode offers facts, objectivity, logical proofs, and reasoned hypotheses, while from the study of literature we come to understand the "vicissitudes of human intention" (p. 17). Britton (1983) similarly contrasts the rule-governed thought of the scientist with the many-sidedness of literary thought, suggesting the complexity of the latter is necessary for understanding the human experience. It is the focus on the human situation described by both Bruner and Britton that draws the individual into the act of thinking—as she or he experiences the events, emotions, and intricacies of human life. The experience, in turn, becomes available for analysis and reflection.

Such issues underlying narrative understanding are critical for the next generation of work in the teaching of literature, yet they are not sufficiently well developed to drive new conceptualizations of the role of literature in the curriculum, nor of how to teach it. We need to learn more not only about distinctions between literary and other readings, but also about the nature of the meaning-making process itself.

Klemenz-Belgart (1981) suggests the need to use current theories of text understanding in studying ways in which readers comprehend text, while theorists as diverse as Bahktin (1973), Culler (1980), and Barthes (1974) call for increased understanding of the conventions readers refer to during the sense-making activity. Culler (1980), for example, suggests the need for a reorientation of focus from corpus to interpretive strategies:

> To account for the form and meaning of literary works is to make explicit the special conventions and procedures of interpretation that enable readers to move from the linguistic meaning of sentences to the literary meaning of works. . . . In brief, I am arguing that if the study of literature is a discipline, it must become a poetics: a study of the conditions of meaning and thus a study of reading. (p. 49)

It was to better understand the act of literary reading, particularly in students, that this study was undertaken—to begin to describe the nature of literary understanding and to relate it to the kinds of meaning-building students engage in when they read other kinds of text. Rather than examining the expressed content of students' understandings, the focus was on the approaches they use in developing that understanding during the reading both of literary and of informative works. The study asked this question: How do students go about understanding literature, and how is this related to the ways they make meaning when reading science and social studies selections?

Theoretical Starting Points

When one begins a study of this sort, there are a number of theoretical assumptions that are implicit in the conceptualization of the work. In this study, there are at least three such assumptions: (1) that reading is an experience of growing understandings that change over time, and thus is essentially an interpretive act (I mean this in the sense used by reading theorists, and not in the sense of formal interpretation discussed by literary critics); (2) that although meaning resides in the reader, not the text, readers follow certain conventions which are signaled by linguistic features in the piece being read; and (3) that approaches to reading are functionally driven, informed by pragmatic needs to personalize or objectify experience, and affect the universe of discourse the reader selects to guide envisionment-building.

Reading as an Act of Envisionment Building

Reading is sense-making, an act of becoming—where new questions, insights, and understandings develop as the reading progresses, while understandings that were once held are subject to modification, reinterpretation, and even dismissal (Anderson, Spiro, & Montague, 1977; Goodman, 1970; Iser, 1978; Rumelhart, 1975; Spiro, Bruce, & Brewer, 1980; Suleiman, 1980). At any point in a reading, the individual has a local envisionment, a personal text-world embodying all she or he understands, assumes, or imagines up to that point in the reading (see Fillmore, 1981; Kay, 1987; J. Langer, 1985, 1986, 1987). However, this is momentary—subject to change in response to subsequent thoughts that may be (but are not necessarily) text-based. The final envisionment, then, is never the sum of previous traces, but is instead an evolving whole, which itself is subject to change well after the pages have been removed from sight. In this view, reading *is* interpretation (Sontag, 1956), and if one wishes to understand this act of interpretation it is necessary to examine the reading experience across time, as the reader traverses the course of meaning-making.

Relationships Between the Reader and the Text

The question posed by this study, about the different kinds of thinking readers experience in reading literary and other kinds of texts, suggests from the outset the belief that the text cannot be ignored in its contribution to the reader's meaning; although the reader's purpose plays a major role in how the meaning is orchestrated, the text itself influences the reading. Texts function semiotically, providing an array of signs and guideposts to evoke ideas and images which are helpful in signaling and underscoring particular ideas that are important to the reader's construal of a particular piece—texts follow conventions that are helpful in arousing readers' thoughts in ways that go beyond what words alone can do (Grice, 1975; Iser, 1974; Searle, 1969). As Pratt (1976) and Smith (1978) have argued, the issue of literary and non-literary readings requires examination of the pragmatic function of the texts themselves. A social relationship develops between reader and text (Booth, 1988; Hunt & Vipond, 1985; Vipond & Hunt, 1984; Vipond, Hunt, & Wheeler, 1987) in which readers, as in everyday discourse, establish a certain social orientation relative to their perceptions of the text. While readers may respond differently to texts depending upon their perceptions of the implied text or implied audience (Booth, 1988; Rabinowitz, 1987), *they* make the choice of how to orient themselves, and this determines whether their approaches toward understanding a particular text will proceed in a predominantly literary or non-literary manner. When readers treat the text in a literary manner, as S. Langer (1942) suggests in her work on the symbolic function of language, from the very first few words they are drawn into the text, leaving the everyday world behind. They seek to identify the genre from the moment reading begins, and these early hypotheses, although subject to change, help shape how they read and the meanings they create (J. Langer, 1986). Thus, the reader "weaves a web of feelings, sensations, images, and ideas between the reader and the text" (Rosenblatt, 1978), and a study of the growth of understanding must explain, not ignore, that relationship. To examine this, the present study used a mix of literary and informative selections, but allowed the readers to define their own orientations in relation to each text.

Objective and Subjective Realities

S. Langer (1967) describes human feelings and understandings as emanating both from outside the individual and from within. She refers to these as objective and subjective experience, explaining that both are part of the process of making meaning. However, the different starting points (the objective outer world and the subjective inner world) lead to related but somewhat different symbol systems and approaches toward meaning.

Many scholars who have examined language and meaning have distinguished between these two universes of discourse and their accompanying techniques for representing experience. S. Langer (1942) herself, in her work on the process of symbolization, distinguishes between discursive and presentational techniques; Rosenblatt (1978), focusing on the reader's role, distinguishes between efferent and aesthetic approaches to reading; and Britton (1970), in his work on the development of writing abilities, distinguishes between participant and spectator roles with their associated transactional and poetic techniques. Although developed for different purposes, each set of concepts deals in some way with qualitative differences between literary and non-literary experiences. Each describes on the one hand a situation where the person holds meaning apart, in quest of a more analytic understanding, and on the other hand a situation where the person becomes personally enmeshed in the text world, responding on a more subjective plane. The first can be considered the way of scientific reading (as in Bruner's notion of paradigmatic thought), while the other can be considered the way of literary reading (as in Bruner's narrative thought). The goal of this study was to learn more about the ways in which these modes of understanding occur when students read for literary or informative purposes.

Related Studies

Although there have been many specific studies of "response" to literature, these have focused primarily on content analyses of expressed responses rather than examining the knowledge and strategies that contribute to students' understandings. From these studies we know: that younger children focus on "action" rather than "interpretation" (Applebee, 1978; Mason, 1974; National Assessment of Educational Progress, 1973); that ability and achievement differences have little effect on the content of expressed responses except as by-products of comprehension problems (Angelotti, 1972; Auerbach, 1974; Faggiani, 1971); that older students are more likely to give "interpretive" or "formal analytic" responses (Cooper, 1969; McGreal, 1976; Purves, 1973); that girls are more likely than boys to verbalize "engagement" or "involvement" in a story (Purves, 1973); that the content of students' responses varies over time during the course of reading or rereading (Angelotti, 1972; Beach, 1972; Britton, 1954; Squire, 1964); and that there are strong effects tied to the particular literary selection chosen as stimulus (Angelotti, 1972; Cooper, 1969; Cornaby, 1974; Purves, 1973; Weber, 1973).

A small number of studies have focused on the strategies readers use when approaching text. Hunt and Vipond (1985) distinguish among story-driven, information-driven, and point-driven orientations, indicating ways in which the different purposes for reading affect response, while Vipond and Hunt (1984) illustrate particular cognitive strategies associated with point-driven readings of literary texts. Jacobsen (1982) describes college students' unwillingness to suspend disbelief or apply their own experiences in order to enter the text-world or "potential space" of short stories, and Dillon (1982) describes three styles of reading based on readers' perceptions of the chronological sequence or event chain of the story, arguing that readers understand life and literature in similar ways. Rather than focusing on the expressed content, as much of previous work has done, there is compelling theory concerning language and thought that supports further study into the ways students create their understandings. To develop this theory, this study focused on the act of reading from the reader's vantage point.

The Study

In particular, this qualitative study sought to describe the ways in which middle and high school students create meanings when they are reading for literary or informative purposes. The student-informants attended two cooperating school districts, one an inner city and one a suburban district. The superintendents, principals, and English department chairpersons all expressed an interest in supporting Literature Center project activities, of which this study was a part. One middle school and one high school were selected in each district. The suburban schools were in middle-class bedroom communities; students were generally bused to schools; approximately 49 percent of the high school graduates went on to 4 year college; and 29 percent went on to other forms of post-secondary school education. The city schools had all of the characteristics usually associated with inner-city environments. Although the community was integrated, the children were predominantly minority and predominantly from poor families; businesses and residences were nearby; children generally walked to school; only 27 percent of the students went on to four

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year college; and 39 percent went on to other forms of post-secondary education.

To enlist participants, the teachers and research assistants described the project to the students, inviting them to become involved; all 7th and 11th graders and their parents also received letters requesting their consent for participation. Of those who responded, 18 were chosen at each grade level, with 9 students at each grade in each school (3 considered as average, 3 as above average, and 3 as below the norm for their grade in their school based on statewide standardized test results corroborated by teacher judgment). Thus, the 36 students were selected to permit us to learn about literary meaning-making strategies across a cross-section of students from two diverse districts.

Materials

A review of available short stories, poems, science selections and social studies selections led to consideration of some 80 works, all of which were typical of those found in school collections and magazines designed for students in junior and senior high school, and each of which could be read by both 7th and 11th graders. The initial selection was narrowed to 8 poems, 8 stories, 4 social studies texts, and 4 science texts which were then field-tested for appropriateness. The field tests consisted of students reading and discussing the texts, and indicating whether they thought the texts would be familiar to and of interest to other students like themselves. The chosen texts did not present extreme difficulty for any of the field-test students to read, and met their criteria for recommendation. The final selections were: "Man by the Fountain" (Hebbelinck, 1973: short story), "I See You Never" (Bradbury, 1973: short story), "The Fish" (Bishop, 1968: poem), "Forgive My Guilt" (Coffin, 1966: poem), "Birth of the Moon" (Birnbaum, 1986: science) and "E. R. A.: Triumph of the American Nation" (Todd & Curti, 1986: social studies).

Procedures

Over a series of meetings, each student completed a training session and think-aloud protocols on six texts. The think-aloud procedure clearly does not capture all of a reader's thoughts and strategies and creates an artificial reading situation (limitations are well-described by Ericsson & Simon, 1984; and Afflerbach & Johnston, 1984), but it has proven to be an effective technique for examining how students orchestrate their reading and writing strategies over time (Flower & Hayes, 1980a; Hayes & Flower, 1980b; Hunt & Vipond, 1985). In an earlier study (Langer, 1986), I compared think alouds and stimulated recalls during reading and writing, and found that think alouds tended to be longer and contained some of the more momentary decisions that were no longer remembered during stimulated recalls. The earlier study also found that the think-aloud procedure did not lead to distortions in students' comprehension of what they had read or in the texts that they wrote.

During the first meeting, each student was introduced to the think-aloud procedure, and practiced it with preselected short stories, poems, social studies texts, and science texts until he or she felt comfortable with the experience. The students were encouraged to verbalize their thoughts when they felt comfortable doing so, rather than at a predetermined boundary such as at the end of a sentence or paragraph. This was done to minimize the distractive effect of the think-aloud procedure on the development of meaning.

Each student participated in 6 think-alouds, in response to 2 short stories, 2 poems, 1 science text, and 1 social studies text. Order of texts was counterbalanced. Each session was approximately 40 minutes in duration. Students were asked to read each selection in the manner in which they generally read works of that sort. Rather than prompting the students to read the poems and short stories for literary purposes (for the experience) and the science and social studies selections for informational purposes, the choice of orientation was left to the students themselves; they made the choice based on the influence of the text's structure and the purpose they set for themselves. As will become clear in discussing the results, the literary and informative texts did evoke consistently different orientations, reflecting different purposes for reading.

Analyses

All analyses were qualitative in nature, involving successive steps of data reduction and verification. To accomplish this, each of the transcripts was carefully read, first separately and later in comparison with the other transcripts, in a search for patterns of "on-line" concerns the students voiced during reading. Once identified, specific evidence for these patterns was sought by returning to the transcripts for examples in the students' own language. A recursive process of refining patterns and returning to the transcripts for evidence was repeated until the patterns identified accounted for all of the individual comments in the student transcripts. The endpoint of the recursive analyses was a final list of categories along with students' language samples, with each language example identified as to the time it occurred during the reading (beginning, middle, or end). Annotation of data, recursive analyses, and identification of recurring themes and patterns provided qualitative reliability (Goetz & LaCompte, 1984).

The transcripts from all of the readings of all the selections were analyzed, and the findings reported are based on the complete set. Throughout this report, however, two pieces, a short story ("I See You Never") and a science selection ("Birth of the Moon"), will be used as examples. They were selected because they provided the clearest and most consistent examples of the patterns represented across all the readings.

"I See You Never" (Bradbury, 1973) is about Mr. Ramirez's imminent deportation to Mexico. He is an illegal alien who has clearly enjoyed living and working in the United States and would like to stay. However, he over-extended the tenure of his visa, was apprehended by the police, and was escorted to his apartment in order to pick up his belongings. Mrs. O'Brian, his landlady, seems deeply moved by his predicament, slowly realizing, as Mr. Ramirez had pointed out, that they would never see each other again.

"Birth of the Moon" (Birnbaum, 1986) is about the impactor theory of the moon's formation, positing that billions of years ago a planet-like object with a core of iron impacted with the earth, sending hot gasses and other material into space. These materials held together, forming the moon. The theory explains that the moon and earth have both similar and different chemistries because of the ways in which particular chemicals were deposited or interacted as a result of the original impact.

Results

Findings in this study concern the meaning-making process itself and the approaches the students used when reading for literary or informational purposes. These findings indicate that the process of reading is one that involves a variety of changing stances that the reader takes toward the text. The focus of the reader's concerns in each stance differs considerably. The sections that follow will first explore the nature of these stances, and then turn to the characteristics that differentiated readers' approaches to reading for literary as compared to informative purposes. The focus throughout will be on patterns that held across the diverse group of readers, in spite of their differences in age, levels of achievement, and types of schools and communities.

Stances in the Process of Understanding

Analyses of the think-aloud reports focused on the ways in which readers engaged in creating meanings as they read. These analyses indicated that as the readers developed their meanings across time, their stances (the ways in which they related to the text) changed, with each stance adding a somewhat different dimension to the readers' understanding of the entire piece. These stances were recursive rather than linear (they had the potential to recur at any point in the reading) and were a function of varying reader/text relationships.

The four major stances used in the process of understanding as they emerged in this study were:

- *Being Out and Stepping Into an Envisionment*—In this stance, readers attempted to make contacts with the world of the text by using prior knowledge, experiences, and surface features of the text to identify essential elements (e.g., genre, content, structure, language) in order to begin to construct an envisionment.
- *Being In and Moving Through an Envisionment*—In this stance, readers were immersed in their understandings, using their previously-constructed envisionment, prior knowledge, and the text itself to further their creation of meaning. As they read more, meaning-making moved along with the text; readers were caught up in the narrative of a story or were carried along by the argument of an informative text.
- *Stepping Back and Rethinking What One Knows*—In this stance, readers used their envisionments of the text to reflect on their own previous knowledge or understandings. Rather than prior knowledge informing their envisionments as in the other stances, in this case readers used their envisionments of the text to rethink their prior knowledge.
- *Stepping Out and Objectifying the Experience*—In this stance, readers distanced themselves from their envisionments, reflecting on and reacting to the content, to the text, or to the reading experience itself.

The nature of these stances and how they contributed to readers' understandings will be discussed below, with examples from the verbal reports of various students. The examples have been selected in order to provide a range of illustrations of readers' concerns within each stance. A more extended, coded selection from a think-aloud protocol of "I See You Never" is included in the appendix as an illustration of the ways in which the stances interplay during a single reading.

Being Out and Stepping Into An Envisionment

Being out and stepping into an envisionment describes a somewhat distant relationship between the reader and the text. In this stance, the reader tries to establish a context for understanding the piece, usually by asking questions and making associations. This stance occurred as the reading began, and again when a reader encountered unexpected or unfamiliar vocabulary or information at any point in the reading. It was a time when readers' envisionments did not cohere, because they had not developed a sufficient core of text-related knowledge to build upon. In literature, readers tried to make contact by examining such features as characters, plot, and setting—and how they interrelated; in dealing with the informative selections, readers tried to make contact by figuring out what the point of the piece would be or what the topic was about. In each case, they sought information from the text to put together with their background knowledge to get enough information to "step in."

Examples from literary texts. When the readers encountered stories, one of the things they tried to establish was who the characters were—they asked questions and made hypotheses about the characters' identities, where they came from, how they looked, and what they were like. For example, Susan simply noted the appearance of characters and made an initial hypothesis about Mr. Ramirez's ethnicity when she began to read "I See You Never." (In the following transcript segments, the actual text is unmarked, and the students' comments are italicized.)

> The soft knock came at the kitchen door, and when Mrs. O'Brian opened it *okay, there's one character, Mrs. O'Brian* there on the back porch were her best tenant, Mr. Ramirez, *I don't know, that sounds like a Spanish name* and two police officers. *Okay, so right there there's four characters—one policeman on each side of him.*

Jack's attempt to step into an envisionment went beyond identification, toward an understanding (however superficial) of the character:

> From the first, he had made big money. He saved some of it, and he got drunk only once a week, a privilege that to Mrs. O'Brian's way of thinking every good workingman deserved, unquestioned and unreprimanded. *Okay, so she's not really, she's not a conservative woman per se. She thinks it's ok for him to save some money and get drunk on the rest if that's what he wants to do.*

When in this stance, readers sometimes also noted the genre, the form, or the style of the piece—any feature of the text that might help them relate the text to what they already knew. For example, when Marguerite began to read she was surprised by the language of the title and tried to understand it before moving on:

> I See You Never. *That's a pretty strange title. It doesn't, I mean grammatically, it doesn't make sense. I would say, "I Never See You," But, I See You never almost sounds like a foreigner saying this, or someone who doesn't know English that well.*

Susan used a different approach to making contact, noting that the dialogue in the story differed from the internal monologue used in other short stories she had read:

> Mr. Ramirez just stood there, walled in and small. "Why, Mr. Ramirez," said Mrs. O'Brian. *This is going to be different from the other ones I've read. This one has conversations in it.*

In being out and stepping into an envisionment, readers sometimes used hypotheses about the relationships among the characters as a way to establish an initial understanding of the situation. Susan's attempt to understand the relationship between Mrs. O'Brian and Mr. Ramirez exemplifies this:

> He had arrived at Mrs. O'Brian's rooming house more than two years earlier and had lived there ever since. *So, I wonder if Mrs. O'Brian and Mr. Ramirez are really good friends.*

Other readers used details of time or setting to relate the story to situations that were familiar, giving themselves a way to begin to construct an envisionment. Focusing on the setting, Jack said:

> He had come by bus from Mexico City to San Diego. *Okay, so this is taking place in California. I think San Diego is in California.* There he had found the clean little room with glossy blue linoleum and pictures and calendars on the flowered wall. *Okay, so it's a nice quaint California rooming house. Flowered walls, that paints a pretty picture in my mind.*

Familiar situations used to contextualize the story were not always positive, as is evident in Robert's comments:

> From the first, he made big money. He saved some of it, and he got drunk only once a week. *I wouldn't want to get drunk. And that's often. I really don't like drunks.*

Although this stance occurred most often early in a story, it also resulted later when students encountered vocabulary or situations unfamiliar enough to take them out of the story to puzzle over the meaning of a word (e.g., *I wonder what adobe is?* and *What does 'reprimanded' mean?*).

In each of these examples, the students used the meaning sources at their disposal, their own experiences and knowledge as well as the text, to gain enough understanding to step into the world of the story.

Examples from informative texts. Being out and stepping into an envisionment also characterized an important stance when students were reading for informative purposes. In this stance, students sought to identify the topic, the meaning of a particular segment, the genre and organization of the piece, or the surface language in order to have a way to step into the world of the text.

From the moment they began to read, many students tried to make sense by focusing on what the topic might be and what they already knew about it. Marguerite's comments when reading "Birth of the Moon" exemplify this:

> A planet the size of Mars comes hurtling through space at 25,000 miles an hour and smashes into the earth. *They're talking about the Big Bang theory or something.*

Lesley similarly began by trying to establish the topic:

> Rocks vaporize. And a jet of hot gas squirts violently into outer space. A bright, hot flash lights up our solar system. *Maybe it's explaining how the moon came about. Like the beginning.*

In this stance, readers were also aware of whether the language and vocabulary of the text clarified their understandings or whether it got in the way. Marguerite found the descriptions helpful:

> Earth is blasted out of shape. Rocks vaporize. *These are really good descriptions. I can even see like bombs bursting in air.*

Cara, on the other hand, wondered: *Well, what are neutrons?*

Students also drew on their previous knowledge and experiences to help them develop initial understandings of the text. For example, when reading about manganese and silicon, Robert stretched to make a connection from what he knew to the unfamiliar chemicals he was reading about:

> The rocks were called (also contained) manganese and silicon, just like earth. *Silicon reminds me of silicone, and at home we have to keep putting silicone inside the windows because the water always gets through every room.*

To sum up this stance, when readers were trying to step into an envisionment, they drew on both their background experiences and the text itself to help them enter into the world of the text. In "I See You Never," they were most likely to focus on the people, place, and situation, while in "Birth of the Moon" they were more likely to focus on information that might identify the topic or establish a relationship between the text and what they already knew. In each case, they used both the information from the text and their background knowledge to gain enough ideas to "step in." Although being out and stepping into an envisionment occurred primarily at the beginning of a reading, readers also entered this stance during the middle of reading, when characters, information, language, or ideas were introduced that were unfamiliar enough to take them out of their envisionments—requiring the period of acquaintanceship afforded by this stance. And, if new or totally unexpected information were to occur at the end (which was not the case in any of the pieces we used), it is conceivable that being out and stepping in could occur at that point in the reading as well.

Being In and Moving Through an Envisionment

Being in and moving through an envisionment describes the engaged moments when readers used their personal experiences and knowledge as well as the text to push their envisionments along—where meanings begot meanings. In this stance readers already had gained initial understandings of particular aspects of the piece, and were using the ongoing text to build an evolving envisionment. In each domain, they continued to develop their understandings beyond the superficiality of the "being out and stepping in" stance, elaborating upon and making connections among their ideas as the text progressed.

Examples from literary texts. In the reading of "I See You Never," this stance was marked by readers' comments about their increasing understanding of the story, whether of the characters, the situation, or the actions taking place. We can see this in Robert's comments about his understanding of Mrs. O'Brian:

> She remembered the slow dragging horses and the parched jack rabbits on the road. She remembered the iron mountains and the dusty valleys and the ocean beaches that spread hundreds of miles with no sound but waves. *I can see now, she's feeling sorry for Mr. Ramirez, cause, like the conditions in Mexico aren't as good as they are in San Diego—no cars, no buildings, nothing. That would be terrible.*

Susan's comments similarly reflect her developing understanding of how Mrs. O'Brian and Mr. Ramirez feel about the situation:

> I'm sure sorry, Mr. Ramirez, she said. *I guess she doesn't sound like she wants him to leave, and I don't think he wants to go either.*

In this stance, readers also commented on their own personal reactions to the situation as they see it, as in Tanya's remarks:

> Mrs. O'Brian, I see you never. I see you never. The policemen smiled at this, but Mr. Ramirez did not notice it, and they stopped smiling very soon. *Don't the policemen like have any feelings toward this man? He wants to stay so badly. And he makes all this money.*

Other comments in this stance reflected the ways in which readers were connecting past envisionments to their present reading, as Jack did in the following:

> She remembered the silent towns, the warm beer, the hot thick foods each day, the beer *the beer reminds me of him getting drunk once a week, the hot thick food each day reminds me of the many courses he might have had,* the silent towns, *silence loneliness, kind of symbolizes Mr. Ramirez. Mr. Ramirez doesn't say too much. The only time when he really shows affection or anything is when he says thank you, unpacked, like 'I have my bag all ready, here's the key Mrs. O'Brian,' and still he calls her Mrs. O'Brian, which means he has respect for her, I'm sure.*

Susan's comments similarly reflected how she was weaving the parts together in this stance:

> He reached out his hands and took her hand fervently, shaking it, wringing it, holding to it. "Mrs. O'Brian, I see you never, I see you never." *That's where the title of the story came from. I don't think he speaks*

> *English very well. I'm not sure though, but the way he just said that, I don't think he can speak English very well.*

Jack, on the other hand, considered Mrs. O'Brian's return to the table from her children's perspectives as well as her own, illustrating his interpretation of the characters as well as his sharp judgment about them:

> *I bet all her five kids feel bad because they want their dinner, don't they, and then it's cold, they're complaining, they're brats . . .* "Hurry up Mom, said one of her sons. It'll be cold." *Oh, shut up. This kid's making me mad. It'll be cold. I mean sometimes you gotta bear with it. I mean, come on, this guy is leaving forever. I'm sure she really doesn't care if her steak is cold, personally.*

Thus, when readers were being in and moving through an envisionment during the reading of a story, their comments reflected an immersion in the envisionments they were creating, as they developed and deepened their understandings of the characters, situations, motives, and emotions that underlie the story.

Examples from informative texts. Similarly in reading informative texts, readers who were in and moving through an envisionment were involved in refining their understandings and making connections as they moved through the text.

Thus Lesley linked what she had just read into her overall understanding of "Birth of the Moon":

> A jet of hot gas squirted thousands of miles into space. *So they're telling us that when it hit the earth that parts of it clipped the moon, and that's why they're alike and that's why they're different.*

As they clarified their understandings of the evolving text world, readers in this stance also commented on their interpretation of the logic of an extended presentation of information. The following segment of Susan's transcript exemplifies this:

> The big crash blasted the impactor apart. *Okay, so that means that when this object hit the earth, that this crash blew it apart so it was all in little pieces.* Its iron core tore away from its rocky surface. *Okay, it had iron, like metal stuff in the middle, and rock on the outside, but I thought the core was, oh, yeah, okay. That's right. I thought the core was made of rock, but no, it's not, It's made of iron. That's better now.* and plunged straight into the center of Earth. *Okay, so I wonder if that's how these, how we got that stuff in the middle, in the core, of our planet.* Rocks vaporized. Parts of the earth's surface were ripped to bits too. Okay, so not only was the impactor blown apart, part of the earth was too. So, now I'm beginning to see.

To elaborate their envisionments, readers in this stance also drew on related knowledge, as Marguerite did:

> And the moon rocks had very few volatiles (materials that boil away during the hot explosions, such as water, sodium, potassium, and

> lead). *Oh, maybe that's why there aren't life forms on the moon, because there's very little water, and you can't live without water.*

Jack similarly drew on related knowledge and experience, though of a more personal sort:

> How could they explain this confusing rock chemistry? Why were the moon rocks like earth, but different from it too? *Well, not everything's the same. Even if it comes from, like a baby and a mother, I mean, I'm not exactly like my mom. I'm not anything like my mom, actually, Cause I'm a boy and she's a girl. But, I'm also different like everything else is different. It doesn't have to be exactly the same to come from it.*

To sum up this stance, in being in and moving through an envisionment, readers drew on personal experiences and information in the text to move their understandings along. In "I See You Never," they focused on their understanding of people and the relationships among them to fill out their understanding of the story, while in "Birth of the Moon" they tried to understand each new explanation by linking it to what they already understood the text to have said.

For the students and texts studied, the first two stances predominated, with the readers' major attention focusing either on getting acquainted with the situation or stepping in and moving through their envisionments. However, the next two stances also occurred consistently in the readings, even though less frequently.

Stepping Back and Rethinking What One Knows

Stepping back and rethinking what one knows describes the thoughts that occurred when readers who were already immersed in creating an envisionment stepped outside of that world for a moment and used their growing understandings as ways to reflect upon their own lives or their own knowledge.

Examples from literary texts. Readers encounter many situations in which the world of the text causes them to rethink their prior knowledge and experiences. Marguerite, for example, adopts this stance when she encounters a description of food she has never tried:

> Mr. Ramirez saw the long table, laid with clean white linen, and set with a platter, cool shining glasses, a water pitcher with ice cubes floating inside it, and a bowl of fresh potato salad, and one of bananas and oranges, cubed and sugared. *I don't think I've ever had bananas and oranges cubed. And I don't think I would like sugar on them, but maybe I would. It might be interesting to try.*

Tanya, on the other hand, stepped out of the text to reflect on the options for dealing with strong emotions:

> She pulled the chair out and sat down. She picked up the shining knife and fork and started once more upon her steak. *It never happened*

> *to me, but I know I would feel like Mrs. O'Brian and not be able to eat my steak. She makes me see you don't have to pretend when you're feeling so sad.*

Examples from informative texts. Readers' comments reflected a similar set of relationships to the text when they read for informative purposes. In this stance, they used their understandings of the text to inform (and often rethink and revise) the knowledge they already had. We can see this in Robert's comments, in which he used information about the moon to rethink what he knew about Jupiter and Saturn:

> As a result a lot of material went into orbit around the earth. It formed a disk, sort of like a pizza. *That reminds me of Jupiter or Saturn because they have rings of dust and stuff. I wonder if it isn't dust. Maybe it's like chemicals like in the moon, and maybe they are part of another impactor crash.*

Marguerite used what she read to rethink the little she had heard about moon rocks:

> In the 1960s and 1970s, astronauts on the Apollo missions brought back moon rocks to Earth's laboratories for the very first time. *I remember hearing about that. I thought they were in a museum, but maybe they can't be. I wonder if they have radiation and volatiles that make them dangerous, or maybe they're really more like the earth than people think.*

And John used what he read about the moon to form an hypothesis about Haley's comet:

> Our round, gray moon was formed. *So, maybe this is how Haley's comet was formed too.*

In other stances, readers used their background knowledge and experiences to help them understand the text, but in this stance they used their envisionments of the text world in reverse—to help them reflect on something they knew, did, or felt before having read the text. In this sense, "being out and stepping into an envisionment" and "being in and moving through an envisionment" involved use of prior knowledge to inform and enrich their envisionments, while in "stepping back and rethinking what one knows" readers used their envisionments to reflect on and sometimes enrich their real world. There was a symbiotic relationship as readers' emphases moved between "real world" knowledge and experiences and "text envisionments," permitting each to illuminate the other. Thus, the degree of elaboration of readers' responses influenced the richness of both text and personal knowledge.

Stepping Out and Objectifying the Experience

In the fourth stance, stepping out and objectifying the experience, readers distanced themselves from the envisionments they had developed. They used this stance to reflect on the reading activity, their understandings, and their reactions. They also commented on the text and the reading experience itself.

Examples from literary texts. Sometimes readers used this stance to comment on their personal reactions. Thus Robert voiced his reaction to the piece as a whole as he finished reading "I See You Never":

> *That wouldn't be what I would choose to read, but it was pretty good. It's sad, but good. I think I like how it was written.*

Other comments in this stance sought to explain the characters and their reactions; Marguerite's comments reflect this emphasis:

> *So, she probably liked the guy. It finally hit her that he's going away, and she's never going to see him again. She probably liked him a lot.*

Jack's comments, on the other hand, pointed to the questions he still had:

> *The whole story is very sad. This is an interesting story, but it's confusing in parts. I still don't know what time period it's in. I still really don't know exactly what relationship they have. Obviously she's just his landlady, I guess. So, I don't know. This is an interesting story.*

Examples from informative texts. The students' comments revealed a similar stance during their readings of "Birth of the Moon." Susan's comments reflected an attempt to pull the parts together, including the popularity of the impactor theory:

> *Okay, so everything fits together, so they think. I like that theory too. I can see why its their favorite theory, it tells everything, and it really helps you figure out what happened with the impactor crash and the chemicals on the earth and the moon.*

Marguerite, on the other hand, was more concerned with the language of the text, and the problems it could cause:

> *That was an interesting article. Confusing though. It was probably for a science magazine or something. But they should have explained some of the vocabulary a little more. I mean, I knew what they were saying, but maybe not everyone would.*

Robert commented briefly on his judgment of the piece and his experience:

> *That's it. That was pretty good. I learned something from it. I didn't know where the moon might have come from. That was interesting.*

In each of these cases, the students distanced themselves from their envisionment, judged it and its parts, or commented on the meanings they had (or had not) made.

Table 1 provides a summary of the four stances that readers took toward the texts they were reading. Over time, across the reading of an en-

Table 1

Stances in the Process of Understanding

Stance	*Focus*	*Strategies*
Being Out and Stepping Into an Envisionment	gathering information	forms tentative questions and associations in attempt to build text world
Being In and Moving Through an Envisionment	developing an interpretation	uses local envisionments and personal knowledge to build and elaborate understandings
Stepping Back and Rethinking What One Knows	reflecting on personal knowledge	uses growing understandings to rethink previously held ideas, beliefs, or feelings
Stepping Out and Objectifying the Experience	taking a critical stance	distances self from text to examine, evaluate, or analyze the reading experience or aspects of the text

tire piece, each reader wove a growing web of understandings. It was woven through the variety of stances the reader took along the way—getting acquainted, using meaning to build meaning, associating and reflecting, and finally distancing. Through these shifting relationships between self and text, readers structured their own understandings.

Orientations Toward Meaning

The stances described so far were an integral part of the process of understanding when reading for either literary or informative purposes. However, the students' overall orientation, the particular concerns emphasized and the reasoning strategies that the students used, differed substantially in the two contexts. It is these differences that seem to form the basic distinctions between reading for literary purposes or for informative purposes for the students whom we were studying. The two passages chosen as examples in this report also differ sharply in content. However, similar differences in orientation, in the way the readers framed their envisionments, were apparent in the other passages used in the study.

Reaching Toward a Horizon of Possibilities Versus Maintaining a Point of Reference

In any reading, the reader is guided not only by the local envisionment as it exists at that point in time, but also by the reader's sense of the whole.

However, the findings of this study indicate that the role of that overall sense of the whole is quite different when the reading takes place in a literary as contrasted with informative context. During the reading of literature, the sense of the whole changed and developed as the envisionment unfolded—it existed as a constantly moving *horizon of possibilities* (see Iser, 1978, for discussions of horizon). These possibilities changed and developed as the text progressed, emerging out of the developing envisionment of the human situation as reflected in the characters, situations, and relationships portrayed in the text.

In readings of informative text, on the other hand, the sense of the whole provided a steady *point of reference*. As the envisionment unfolded, new details in the text clarified the nature of the whole, but they rarely changed it. Readers used this constancy in their sense of the whole to monitor their understandings (or misunderstandings) of details. Thus readers of both literary and informative texts maintained a sense of the whole, but the nature of this whole was somewhat different. Reaching toward a horizon or maintaining a point of reference occurred across the reading of each piece—providing an overall orchestration within and across the readers' changing stances. Their understanding of literary texts seemed to be constrained by their notions of human possibility, while their understanding of informative texts seemed to be constrained by their perceptions of the topic.

Exploring a Horizon of Possibilities

When readers oriented themselves toward reading for literary purposes, their readings were guided by inquisitiveness, by the opening of possibilities for the meaning of the whole. Readers in this orientation tried to understand what they were reading in terms of its contribution to their developing sense of the whole, rather than relating it to an established topic or point of view. They clarified ideas as they read and related them to the growing and changing horizon of possibilities—that horizon modified the parts and the parts modified the horizon. In doing this, readers continually tried to open possibilities, see many sides, and go beyond their current sense of what the story was about. They considered the underside of the story, projecting unspoken emotions and reactions beyond the ideas that were more directly expressed. They did this by examining the attitudes, assumptions, and intentions reflected in their envisionments. In moving toward horizons of possibilities, their focus was always on the human situation, on the "vicissitudes of life," particular or general. As the readers made sense of their local envisionments, they did it in a context of making sense of the horizon, of the possibilities of the whole, as well.

Let us look once again at the students' comments to "I See You Never" for evidence of these concerns. Throughout the reading of the literary selections, the students attempted to weave the enfolding events into their own changing notions of the story as a whole. They treated new events not only for their use in momentary understandings, but also as having implications for where they believed the story was heading.

Cara, for example, used Mr. Ramirez's protests to weave a picture of what his prospects would be if he did leave the United States. Her comments reflect how she thought the story might evolve:

> I look all right, don't I? And I don't want to go back. *Well, he probably doesn't want to go back because he's sort of made himself a good life in the United States. And if he ever went to Mexico, he might never be able to immigrate to the U. S.*

Her comments reflect a similar exploration of possibilities when she reads Mrs. O'Brian's lament:

> I just realized . . . I'll never see him again. *Well, Mrs. O'Brian is probably upset because, well, when she described the poor [Mexican] landscapes, I can sort of see how it will be for him . . .*

Paul also related the ideas he was focusing on to his growing horizon, to the possibilities of the whole, as he read:

> One of her sons, behind her, said that her dinner was geting cold, but she shook her head at him and turned back to Mr. Ramirez. *Right now, at a time like this, she wants to point all her attention to Mr. Ramirez because she may not be able to see him any more. She doesn't pay attention to her child right now because they will be left, but Mr. Ramirez will be gone.*

As the students focused on the implications of particular ideas for the horizon of possibilities in the story, the directions it might lead, they also turned each idea they read around, using its potential to fill out the unspoken. They attempted to create a three dimensional world, concerned not only with what was said, but also with what was not. Readers thus invented intentions, motivations, and causalities that went beyond their immediate text. In doing so, they created a much larger envisionment of the text.

For example, Lesley focused on possible motivations as she read:

> At this table sat Mrs. O'Brian's children, her three grown sons . . . and the two younger daughters were staring at the policemen as they ate. *So, she must have baked for the policeman. Maybe she's trying to get Mr. Ramirez out of trouble.*

And Paul elaborated on Mrs. O'Brian's intentions as she commented to Mr. Ramirez:

> I'm sorry, Mr. Ramirez, she said, I wish there was something I could do. *It's like she knew all the time that he was here illegally, but she was just trying to help, I guess.*

This filling out of possibilities took place at all levels; Lesley was not interested in motivation, but only with understanding a character's likes and dislikes:

> Pies were baking. *Oh, she must like to bake pies.*

Crystal, on the other hand, tried to understand Mrs. O'Brian's reasons for reminiscing about Mexico by projecting the implications for the whole story:

> . . . with no sound but the waves, no cars . . . , *So, it seems like she's trying to remember what it was like so she can see what he's going back to.*

In reading literature, then, the students took what they read and used it for larger purposes, purposes that went beyond what they were presently reading, already understood, or had imagined might be.

Maintaining a Point of Reference

The process of understanding science and social studies texts was different; with these passages, the students used the content they read to narrow in on increasingly more specific meaning. They began their reading trying to gain a notion of the topic or point of the piece, at least in some broad sense. This done, throughout the reading they tried to understand and clarify what the particular idea they were focusing on meant in terms of its relationship to the topic or point of the whole. Although their understanding of this topic grew and developed, there was no distant horizon of possibilities, no questioning of how the point of the whole might evolve. Instead, their envisionments contained few ambiguities as they narrowed the possibilities of meaning and built a growing web of understandings, all related to the topic which served as their point of reference. The process is similar to that which Polanyi (1958) and Koestler (1964), among others, have described in examining the nature of creativity in the sciences and mathematics: the great breakthroughs have involved the establishment of sense of the endpoint or solution, followed by a (sometimes difficult) period of developing the detailed solutions or proofs to convey it to others.

The following examples illustrate the students' attempts to maintain a point of reference. When reading "Birth of the Moon," Robert struggled to keep everything focused on the topic as he understood it:

> Like Earth, they contained several different isotopes of oxygen . . . *I'm wondering what that has to do with the moon.*

Marguerite similarly established the formation of the moon as her stable point of reference:

> The mystery of the moon's birth would soon be solved. *They're trying to see how the moon was formed.*

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Crystal's comments reflected a similar concern with tying the parts together cleanly:

> . . . and plunged straight into the center of the Earth. *So, this is all just supporting the impactor theory.*

In reading for informative purposes, readers were concerned with clarifying their envisionments and developing a greater understanding of the topic. They focused on connecting information—the text's and their own previous knowledge—as a way to make the individual parts cohere and their understanding of the topic take shape. When they asked questions, the questions were the sort that are topic-related and are generally provided by the text—often they anticipate the text--and these questions were soon answered.

Cara continued to tie her understanding of the parts of the text together around the topic, consolidating her sense of how earlier parts fit:

> So the moon was left without metallic iron, *Well, that's interesting 'cause it sort of explains what they were trying to explain in the beginning of the article.*

Lesley's comments also reflected his growing understanding of the topic as he read:

> A jet of hot gas squirted 1000 miles into space. *So what they're telling is that when it hit the Earth that parts of it clipped to the moon, and that's why they're alike and that's why they're different.*

Thus, reading for literary purposes and reading for informative purposes appear to be guided by different concerns and involve different kinds of thinking; these two different orientations are summarized in Table 2.

The reading of a literary work seems to operate much as Polanyi's (1958) notion of indwelling, where the person lives within the experience,

Table 2

Orientations Toward Meaning

Literary:	
Reaching Toward a Horizon of Possibilities	Readers explore both their local envisionments and their overall sense of the whole as they enter into and reflect upon their text worlds
Informative:	
Maintaining a Point of Reference	Readers clarify their ideas and construct their text worlds by relating what they read to their relatively stable sense of the topic or point of the piece

stretching it in all directions, questioning and reconciling the sometimes disparate parts into a coherent and productive whole—readers open possibilities and move toward an increased understanding of causes, implications, and feelings by moving toward an ever changing horizon that represents their sense of how the story might evolve. In contrast, in reading for informative purposes they elaborate on their understanding of the topic by maintaining a relatively stable point of reference toward which they build their understandings. Both orientations allow for creativity and the elaboration of new ideas; both are powerful modes of thinking and problem solving; but they function in very different ways.

Discussion

This study provides a description of the process of understanding when reading for literary or informative purposes and suggests the different approaches toward meaning readers engage in when reading in these ways. When they approach a text, there are four broad stances readers adopt to carry them through the experience. These are: "being out and stepping into an envisionment," where readers make the connections necessary to begin to construct an envisionment; "being in and moving through an envisionment," where they use their envisionments to inform their growing understandings; "stepping back and rethinking what one knows," where they use their envisionments to reflect on personal experiences, ideas, or knowledge; and "stepping out and objectifying the experience," where they look critically at their envisionments, their reading experiences, and the text itself. Across the reading of an entire piece, reading is an act of becoming, where readers use their past experiences, the text, and their local envisionments in different ways as they move in and out of the various stances as their understandings grow and develop.

The stances readers took toward the texts they read were shaped in part by their initial decision to treat the texts either as literary or informative. While readers entered similar stances in each reading experience, the focus of their concerns within each stance and thus the ways in which they approached the making of meaning differed based upon the overall orientation they had chosen. In reading for informative purposes, the students worked closely, using their notions of topic as a frame of reference, building and refining meanings as they moved toward a more complete understanding of the topic—toward an understanding of what *is*. However, during the reading of literature, they treated their growing understandings more openly, raising possibilities about the horizon as well as about their momentary ideas, focusing on the human situation, seeking to understand interplays between events and emotions and eventualities—toward an understanding of the implications that might be implied in the situation depicted. Both approaches moved the readers to understand, but in different ways, toward different meanings.

Through this lens, we see evidence that when engaged in the tasks set for them in this study, the students treated literature as experience and not as information. They used literature to invoke insights about the human condition, using their own perceptions of what it means to be human in the new contexts of what they read. In doing so, they sometimes contemplated not only the characters and situations embodied in the text, but also themselves and the world around them.

These findings suggest that meaning develops at two levels simultaneously. First, student readers have different assumptions about responding to literary versus non-literary texts, and these affect the ways in which they orient themselves toward creating their momentary understandings as well as their views of the potential of each piece as a whole. At the same time, the similarities in the processes involved in responding across the different text types indicate that the four stances represent a range of meaning-making options that underlie developing understandings in general—regardless of text type. This suggests that rather than moving "up" a scale of abstraction to an "interpretive" level, students learn to develop a store of qualitatively different options to use in particular circumstances for particular purposes.

Such distinctions are useful in a number of ways. First, the notion of stances based on readers' growing envisionments can provide an alternative to existing category systems that are primarily based on *types* or *levels* of response. Second, the stances are linked to a process of coming to understand—a recursive process of approaching and extending the understanding of texts. Thus, it would be possible to begin to analyze the extent to which readers are or are not willing or able to extend their envisionments in order to reach a fuller response. It may then also be possible to examine reasons underlying readers' successes or difficulties in extending their responses. Considering how students learn to acquire the different stances, as well as the ways in which they engage in the reading of literary and other types of texts, may be useful in conceptualizing reader-based instructional approaches where both students and teachers can become more aware of the array of meaning-making options that are available in the development of understanding.

A number of other issues suggested by these findings require further study. There is some evidence that although the general orientation a reader chooses toward a text is generally maintained, readers occasionally shift orientations in quest of meaning. This is particularly interesting in that texts often blend techniques (e.g., in the middle of a logical argument, the writer may provide a narrative anecdote), thus inviting readers to shift their orientations. Schooling may have similar effects. Because instructional materials often treat literature as informative, offering particular content to be learned or interpretations to be memorized, students may shift meaning-making approaches based upon their expectations about their assignments. Although shifts of these sorts were limited in this study, it is possible that more varied text types, longer texts, or more natural environments might provide more inviting contexts for such shifts to occur. When these occur, by whom, and in response to what texts all need to be better understood.

A final issue suggested by these findings focuses on purposes for reading and the kinds of texts that are read. For example, different kinds of texts as well as different purposes for reading may lead to different patterns in the way students orient themselves to the text and orchestrate their stances. The particular purpose and the particular text, as well as the particular kinds of instruction experienced, all are likely to affect the strategies students learn to use in academic settings. As Bruner (1986) suggests, it is likely that in some instances readers use both orientations, to varying degrees, when reading both types of texts for both types of purposes. Research into this issue will be particularly important as we move toward understanding the place of literary understanding in intellectual development.

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Appendix

Jack's Think-Aloud: "I See You Never"
(selected sections)

Stance

1 I See You Never. *That means someone's probably never going to see anybody. Maybe he's blind.* The soft knock came at the kitchen door. *The soft knock—which means maybe he's not a mean person, a soft person.* And when Mrs. O'Brian opened it, *O'Brian, that's my girlfriend's name, so I picture my girlfriend's mother. She's a very nice old lady.* There on the back porch were her best tenant, Mr. Ramirez, *maybe Hispanic or something like that,* and two police officers. *Police officers, that means there might be trouble.* One on each side of him. *Oh, maybe they're taking him away.* Mr. Ramirez just stood there, walled in and small. *Obviously there's something going on, because maybe Mr. Ramirez got arrested.* . . . He had come by bus from Mexico City. *He's Hispanic* to San Diego, *Okay, so this is taking place in California. I think San Diego is in California.* There he had found the clean little room with the glossy blue linoleum and pictures and flowers on the flowered walls. *Flowered walls, that paints a pretty picture in my mind.* And Mrs. O'Brian as the strict but kindly landlady. *I picture this heavy set woman, blond hair, old, caring. You know, almost like a fairy godmother type. Strict, neat and tidy, but always willing to give of herself.* During the war, *What war, Korean, Viet Nam, I don't know when this took place—maybe even earlier,* he had worked in an airplane factory and made parts for the planes that flew off somewhere. *Somewhere, that doesn't give much of an explanation of where that is.* And even now, after the war, he still held this job. *Okay, so maybe he did something at the airplane factory, in his job. Maybe that's why the police officers are there. I don't know.* Mr. Ramirez gazed at his feet as if they had carried him into all this trouble. *Obviously he's in trouble. Maybe it has to do with Mrs. O'Brian. He did something to her that he's ashamed of.* "What happened, Mr. Ramirez, asked Mrs. O'Brian?". . . . "I have been here 30 months," said Mr. Ramirez quietly, *He seems like he's ashamed of something, I'm not real sure,* looking at Mrs. O'Brian's plump hands. *Oh yes, she's plump, that's exactly how I pictured her.* "That's six months too long," said one policeman. *Six months, that means he should have left at 24 months. Right, 30 minus 6 is 24. And 24 months is two years, so 30 months would be 2½ years. Okay.*

2 "He only had a temporary visa. We've just gotten around to looking for him." *Oh, I see, he's an illegal alien. Okay, I understand. Maybe he's a drug smuggler. No, he wouldn't be staying at Mrs. O'Brian's house if he was a drug smuggler because she doesn't like dirty things in the house, I don't think. He's obviously an illegal alien.*

Reading Comprehension

The Process of Understanding: Reading for Literary and Informative Purposes

1 Soon after Mr. Ramirez had arrived, he bought a little radio for his room. *I don't know. I don't understand that.*

2 Evenings he turned it up very loud and enjoyed it. *Maybe to get away from everything. I mean, she had five kids and her in the little house. That might get a little noisy. Maybe he enjoyed being here. . . . Maybe he didn't like it where he came from. . . . Obviously he didn't like where he came from, and that's probably why he stayed the 30 months instead of 24. . . .* And on many nights he had walked silent streets, seeing the bright clothes in the windows, and bought some of them. *Obviously he's trying to break out. He's from a lonely culture. I see you never. Never, that brings about a thought of loneliness. And his room is small, and he's always trying to, maybe he doesn't like it where he came from. Maybe it was real lonely. . . .*

1 "So, here I am," said Mr. Ramirez, "now to tell you that I must give up my room, Mrs. O'Brian." *Why does he have to give up his room? Obviously he's being taken away, so he has to give up his room. But to who?*

3 "I come to get my baggage and clothes and go with these men." *Okay, so he's being forced to leave. These men. Why does he call them men? I hate policemen. . . . Not that I've dealt with them many times in my life, but what they're doing to Mr. Ramirez makes me not trust them. . . .*

1 "Back to Mexico?" "Yes, to Lagos. . . ." *I wish I had a map here. I don't know where any of these places are.*

2 "I'm sorry, Mr. Ramirez." *I guess she probably likes him. Maybe she's one of his lady friends. . . . He says he has a few lady friends. . . .* "Okay, here's the key, Mrs. O'Brian," Mr. Ramirez said. "I have my bag already." *So, he gave her the key to his room. . . . He only has one bag and he's been there for 2½ years. My God, I went away for a week last week and I brought four bags. . . .* "You've been a good tenant," said Mrs. O'Brian. *A good tenant, is that all?* "Thank you, Mrs. O'Brian," he said softly. He closed his eyes. *He's probably choked up because he was leaving. He's leaving her and he's choked up about that. He will miss her. . . .* One of her sons behind her said that her dinner was getting cold. *So what. Mr. Ramirez is leaving. That makes me mad. The kid is demanding his dinner now. But, he was leaving, and they were never going to see him again. . . .* But she shook her head at him and turned back to Mr. Ramirez. *Good for you, Mrs. O'Brian.* She remembered a visit she had once made to some Mexican border towns . . . the silent towns, the warm beer. *The silent towns, silence, loneliness, kind of symbolizes Mr. Ramirez. Mr. Ramirez doesn't say too much. The only time he shows affection is when he says thank you. Like "I have my bag already, here's the key Mrs. O'Brian." And he still calls her Mrs. O'Brian, which means he has respect for her, I'm sure.*

3 "I don't want to go back, Mrs. O'Brian," he said weakly. *Weakly, that sounds like what I said last week. Last week in Washington I didn't want to come back. Now I know why. 'Cause I'm swamped with homework, and I don't know—there's so much to do, and my friends are all depressed. . . .*

2 "I like it here. I want to stay here." *That's what I said, that's exactly what I said last week and I know what it feels like to go someplace and you like it so much that you don't want to come back. . . .* "Mrs. O'Brian", he cried suddenly, tears rolling out from under his eyelids. . . . "Mrs. O'Brian, I see you never. I see you never." *Does this mean he'll never see her again? . . . I never heard someone say that. Well, maybe he doesn't speak English that well and kind of get the order mixed up. . . . Obviously he likes this lady. Maybe it's like a mother to him. . . .* She watched them go down the porch steps. . . . *She must be very sad.* She pulled out the chair and sat down. *She is sad, I can tell. I bet all her five kids feel bad because they want their dinner. And then it's cold and they're complaining. They're brats. . . .* "What's wrong, Ma?" asked her son. *Oh, come on, don't they understand what's going on? Well, maybe they don't. . . .* "I just realized," said Mrs. O'Brian, "I'll never see Mr. Ramirez again." *Well, that's what he's trying to say, I see you never, which is I'll never see Mr. Ramirez again. But they said it in different ways.*

4 *The whole story is very sad. This is an interesting story, but it's confusing in parts. I still don't know what time period it's in. I still really don't know what relationship they have. Obviously she's just his landlady, but I don't know. This is an interesting story.*

Subject-Area Learning

What Influences Learning? A Content Analysis of Review Literature

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ABSTRACT **This paper reported a comprehensive "meta-review" and synthesis of research on variables related to learning, including both cognitive and affective schooling outcomes.[1] A conceptual framework was developed encompassing 228 items related to school learning, organized a priori into 30 scales within six categories. Search and selection procedures yielded 179 selected handbook and annual review chapters, commissioned papers, and other authoritative reviews. Content analysis yielded over 3,700 ratings of the strength of influence of the variables on learning. The variables confirmed the primacy of student, classroom, home, and community influences on learning relative to more distal policy variables such as state and district characteristics. Additionally, the variables also highlighted the importance of metacognition, classroom management, quantity of instruction, classroom interactions and climate, and the peer group.**

Educational research has identified a large number of variables related to school learning. Because such a multiplicity of distinct influences on achievement have been found, educators may be perplexed as to which items are most important. Educational researchers, policy makers, and practitioners all require clearer guidance concerning the relative importance of different learning influences and the particular variables most likely to maximize school learning. To address this need, we did a comprehensive review and synthesis of handbooks, review annuals, and other highly synthetic prior reviews. We characterized the most authoritative scholarly opinion about ways to optimize educational outcomes across a range of educational conditions and settings. This research synthesis is distinguished by its comprehensiveness, its orientation toward practical school improvement strategies, and its focus on comparing the relative contributions of different items to learning. To organize the synthesis, we developed a conceptual framework that draws heavily on major theoretical models of school learning. Before turning to this framework, we briefly describe the evolution of these earlier theoretical models.

Evolution of Models of School Learning

J. B. Carroll (1963) introduced educational researchers to models of school learning in his aptly entitled article, "A Model of School Learning" in the *Teachers College Record*. In his model, he developed six constructs: aptitude, ability to comprehend instruction, perseverance, clarity of instruction, matching the task to student characteristics, and opportunity to learn. These constructs, which succinctly capture the psychological influences on school learning, became a point of departure for other models to follow. The 1960s and 1970s were marked by the introduction of several additional important models of learning, including those of Bruner (1966), Bloom (1976), Harnischfeger and Wiley (1976), Glaser (1976), and Bennett (1978).

All of those models recognized the primary importance of student ability, and included constructs such as aptitude, prior knowledge, verbal IQ, and pupil background. Most of the models also addressed the importance of motivation, by employing such constructs as perseverance, self-concept of the learner, and attitude toward school subject matter. This acknowledgement of individual difference variables among learners contrasted with the more narrowly psychological studies of influences on learning, which generally treated individual differences as a source of error, and focused instead on instructional treatment variables (Hilgard, 1964).

In addition to student variables, each of the models of school learning noted above also gave salience to constructs developed from studies of classroom instruction. These constructs varied in generality, some being as broad as "instructional events" or "clarity of instruction" and others as narrow as "use of cues" or "feedback and correctives."

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Subject-Area Learning

Although later models brought some refinement in the ways in which individual difference variables and instructional variables were defined and the ways in which they were related to one another, the primary contributions of more recent models have been in extending the range of influences considered. Haertel, Walberg, and Weinstein (1983), for example, identified nine theoretical constructs that exhibit consistent causal influences on academic learning: student age or developmental level, ability (including prior achievement), motivation, amount or quantity of instruction, quality of instruction, psychological environment of the classroom, influence of the home, influence of the peer group outside of school, and exposure to mass media. The researchers showed that previous models of school learning neglected extramural and social-psychological influences.

The evolution of models of school learning was further advanced with the introduction of models of adaptive instruction (Wang & Lindvall, 1984; Wang & Walberg, 1985). School-based implementation of models of adaptive instruction are designed to help schools create learning environments that maximize each student's opportunities for success in school. The models focused on new variables associated with instructional delivery systems, program design, and implementation. Also, the models emphasized those features that Glaser (1982) referred to as the "large practical variables" and included efficient allocation and use of teacher and student time, a practical classroom management system, systematic teacher feedback and reinforcement of student learning behavior and progress, instructional interactions based on the diagnosed learning needs of individual students, and flexible administrative and organizational patterns responsive to program implementation and staffing needs.

Another contribution to models of school learning came from sociologists concerned with the identification of effective schools. Edmonds (1979) is most strongly associated with this identification of variables associated with exceptionally effective schools, especially for the urban poor. Significant contributions to effective schools models also were made by Brookover (1979), Brookover and Lezotte (1979), and Rutter, Maughan, Mortimore, Ouston, and Smith (1979). Illustrations of the types of variables characterizing effective schools included degree of curriculum articulation and organization, schoolwide staff development, parental involvement and support, schoolwide recognition of academic success, maximized learning time, district support, clear goals and high expectations, orderly and disciplined school environment, and leadership of principal characterized by attention to quality of instruction (Purkey & Smith, 1983).

Those various models of school learning all contributed a variety of items, or variables, that may be useful to educational practitioners. Individual researchers may focus their work on particular variables or constructs, but the purpose of this synthesis was to try to provide a synoptic view of the entire panoply of variables.

Methods and Procedures

The first step in developing the meta-review described in this paper was to delineate a comprehensive set of variables organized into an inclusive conceptual framework. Next, we identified a corpus of over 150 books, book chapters, reports, and other sources. The 228 items in the conceptual framework were listed on a detailed, 15-page coding form, and each of the sources was then coded using that form. In all, over 2,500 pages of coding forms were completed. Each citation or discussion of an item influencing learning outcomes was coded by page number, together with a notation of the reported strength of its influence on learning. Those detailed text citations by page number were placed in an archive.[2]

The detailed ratings were then recoded onto a set of summary forms, one for each chapter or other source, which gave overall ratings of strength of influence for each of the items discussed in that source. Those summary ratings were entered into machine-readable files and analyzed to determine the emergent consensus on which items exert the most powerful influence on learning outcomes. The initial coding tabulated well over 10,000 separate statements in the research literature concerning the strength of association between 1 of the 228 items and learning outcomes. Those statements were reduced to over 3,700 summary ratings, which were then keyed and analyzed.[3]

The development of the conceptual framework, selection of the corpus of studies, and coding procedures are described briefly below.

Conceptual framework for items related to learning. The identification of a comprehensive set of items began with a close examination of the models of school learning described above, as well as selected sources, including Brophy (1986), Keogh, Major-Kingsley, Omori-Gordon, and Reid (1982), Wang and Walberg (1985), and Wittrock (1986). Potential variables were written on separate index cards, then consolidated and organized into a preliminary version of the final coding scheme. This draft coding scheme was sent to members of the Scientific Advisory Panel of the Center for Research in Human Development and Education at Temple University.[4] Based on detailed commentaries received from the panel members, the framework was revised to include four additional items and to improve its organization.

The final framework organized the 228 items related to learning into 30 a priori scales within six broad categories. The six categories were ordered roughly from more distal to more proximal factors. Brief descriptions of the categories are presented in Figure 1, together with illustrative items from each scale.

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Subject-Area Learning

Journal of Educational Research

Category/Subcategory[a]	**Illustrative Variable**

Category 1. State and District Variables: These variables are associated with state- and district-level school governance and administration. They include state curriculum and textbook policies, testing and graduation requirements, and teacher licensure, as well as specific provisions in teacher contracts, and some district-level administrative and fiscal variables.

District-Level Demographics and Marker	School district size
State-Level Policy	Teacher licensure requirements

Category 2. Out-of-School Contextual Variables: These variables are associated with the home and community contexts within which schools function. They include community demographics, peer culture, parental support and involvement, and amount of time students spend out of school on such activities as television viewing, leisure reading, and homework.

Community	Socioeconomic level of community
Peer-Group	Level of peers' academic aspirations
Home Environment and Parental Support	Parental involvement in assuring completion of homework
Student Use of Out-of-School-Time	Student participation in clubs and extracurricular school activities

Category 3. School-Level Variables: These variables are associated with school-level demographics, culture, climate, policies, and practices. They include demographics of the student body, whether the school is public or private, and levels of funding for specific categorical programs; school-level decision-making variables, and specific school-level policies and practices, including policies on parental involvement in the school.

Demographic and Marker	Size of school
Teacher/Administrator Decision-Making	Principal actively concerned with instructional program
School Culture (Ethos conducive to teaching and learning)	School-wide emphasis on and recognition of academic achievement
School-Wide Policy and Organization	Explicit school-wide discipline policy
Accessibility	Accessibility of educational program (overcoming architectural, communication, and environmental barriers)
Parental Involvement Policy	Parental involvement in improvement and operation of instructional program

Category 4. Student Variables: These variables are associated with individual students, including demographics, academic history, and a variety of social, behavioral, motivational, cognitive, and affective characteristics.

Demographic and Marker	Gender
History of Educational Placement	Prior grade retentions
Social and Behavioral	Positive, nondisruptive behavior
Motivational and Affective	Attitude toward subject matter instructed
Cognitive	Level of specific academic knowledge in subject area instructed
Metacognitive	Comprehension monitoring (planning: monitoring effectiveness of attempted actions, monitoring outcomes of actions; testing, revising, and evaluating learning strategies)
Psychomotor	Psychomotor skills specific to area instructed

Category 5. Program Design Variables: These variables are associated with instruction as designed and with the physical arrangements for its delivery. They include the instructional strategies specified by the curriculum and characteristics of instructional materials.

Demographic and Marker	Size of instructional group (whole class, small group, one-on-one instruction)
Curriculum and Instructional	Alignment among goals, contents, instruction, assignments, and evaluation
Curriculum Design	Materials employ advance organizers

Category 6. Implementation, Classroom Instruction, and Climate Variables: These variables are associated with the implementation of the curriculum and the instructional program. They include classroom routines and practices, characteristics of instruction as delivered, classroom management, monitoring of student progress, and quality and quantity of instruction provided, as well as student-teacher interactions and classroom climate.

Classroom Implementation Support	Establishing efficient classroom routines and communicating rules and procedures
Classroom Instructional	Use of clear and organized direct instruction
Quantity of Instruction	Time on task (amount of time students are actively engaged in learning)
Classroom Assessment	Use of assessment as a frequent, integral component of instruction
Classroom Management	Group alerting (teacher uses questioning/recitation strategies that maintain active participation by all students)
Student and Teacher Interactions: Social	Student responds positively to questions from other students and from teacher
Student and Teacher Interactions: Academic	Frequent calls for extended, substantive oral and written response (not one-word answers)
Classroom climate	Cohesiveness (members of class are friends sharing common interests and values and emphasizing cooperative goals)

Figure 1. Conceptual Framework With Illustrative Examples

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[a] Subcategories are listed below the description of each broad category and are each illustrated with representative variables. For example, the first broad category includes two subcategories, "District-Level Demographics and Marker Variables" and "State-Level Policy Variables."

Selection of a corpus of studies. A vast research literature addresses one or more of the potential learning influences represented by the conceptual framework, and one could not possibily examine all of the thousands of original studies relevant to a synthesis of this scope. Even the literature of *review* articles is massive. For this reason, we focused on authoritative reviews and handbook chapters, especially those sponsored by the American Educational Research Association and other organizations, and we selected additional syntheses in government documents and other sources. A preliminary list of sources was reviewed by the Scientific Advisory Panel and revised following their recommendations. Following this review, the sources chosen included chapters from the past decade or more of the *Review of Research in Education*, the *Annual Review of Psychology*, and the *Annual Review of Sociology*, as well as the *Handbook of Research on Teaching* (Wittrock, 1986), *Designs for Compensatory Education* (Williams, Richmond, & Mason, 1986), more specialized handbooks, and a small number of journal articles chosen to assure coverage of all of the areas addressed in the comprehensive framework. Initially, over 200 articles, chapters, and other sources were identified. All of those sources were read, but some were excluded from the final corpus because they failed to address kindergarten through grade 12 instruction in regular school settings, because they addressed exceptionally narrow and atypical learning outcomes, or because they were relevant only to rare or special-learner populations.

A total of 179 sources were included in the final corpus of studies (see Appendix for a complete bibliography). All of those sources were relevant to a range of cognitive and affective learning outcomes for kindergarten through grade 12 learners in formal educational settings. Table 1 presents a summary by type of the source documents included in the final synthesis.

Coding procedures. Each source document was coded initially onto a detailed rating form, which allowed the recording of multiple references in a single document to the same item. In addition to coding references to the 228 prespecified items, space was provided for the coding of any additional items related to learning outcomes, referred to on the form as supplementary items. Brief notes also were recorded for most sources, including page references, comments on the source's overall relevance, and any limitations on the learner populations or varieties of learning outcomes addressed. This archived documentation has been retained by the first author.

Table 1.—Number and Percentage of Source Documents by Type

Type of source[a]	*N*	%	Total pages
Chapters for annual review series	86	48	3,179
Handbook chapters	44	25	1,089
Government documents and commissioned reports	20	11	772
Book chapters	18	10	563
Review articles in journals	11	6	152
Total	179	100	5,755

[a] A complete bibliography is available from the first author

Each reference to an item's relation to learning outcomes was coded on a 3-point scale, with 1 representing a weak, uncertain, or inconsistent relation to learning, 2 representing a moderate relation, and 3 representing a strong relation. Where "vote counts" or proportions of confirming studies were reported, a 3 indicated that more than 80% of the studies discussed had found a statistically significant association of an item to achievement, a 2 indicated that between 40 % and 80% of the studies found support for the relationship, and a 1 indicated less than 40% in support. Where results were summarized in terms of effect sizes, we assigned a code of 3 to effect sizes greater than .33, 2 to effect sizes of .10 to .33, and 1 for smaller effect sizes. Where correlations were reported, we used 3 for correlations greater than .40, 2 for correlations of .15 to .40, and 1 otherwise.

In many cases, the source documents did not present quantitative indices like effect sizes or correlations, so we had to judge the strength of the evidence presented from prose descriptions of the conclusions from bodies of research. In those cases, the strength of the evidence presented was judged weak, moderate, or strong, and coded accordingly. Even though all of the 228 items were defined in such a way that they were expected to relate positively to learning, in rare instances the literature reported negative conclusions.[5]

Following the coding of all specific references by page number, we transcribed ratings onto a second summary form for each source, prior to keying for data analysis. At this stage, a single summary code—the average of all the ratings for each source document—was recorded indicating the strength of association for each item discussed in the source, according to the preponderance of the specific references noted.[6]

Data Analysis

After inspecting univariate frequency distributions for each of the 228 separate items to assure that no values were out of range, we aggregated the separate items to the level of the 30 scales described in Figure 1. We accomplished this procedure by taking the average of all nonmissing values in a scale, for each source. In cases where a source document did not discuss any of the separate items in a scale, we entered a missing data code. In those rare cases where negative findings were coded, we retained their negative signs when averages were taken.

In a second stage of data reduction, six additional variables were created corresponding to the categories described in Figure 1. The values of those variables for each source were weighted averages of all nonmissing scale values comprising that category.[7] Means, standard deviations, and alpha reliabilities for the six categories and 30 scales are presented in Table 2. The reliabilities for documents (not raters) ranged from .71 to .99; all but four were greater than .80 and most exceeded .90.[8]

Table 2 also reports the number of sources that discussed items in each scale. Surprisingly, the frequency with which different scale items are discussed in the literature was not a reliable guide to their importance for learning outcomes. The Spearman rank correlation between frequencies and means across the 30 scales was only .10.

Summary of Results

Table 2 presents the importance of many distinct influences on school learning outcomes. Over all 30 scales, the mean rating was roughly 1.8, a little below the level designated "moderate relation to learning." More important, however, the synthesis shows which categories, scales, and specific items are most strongly associated with learning outcomes. In discussing results by category and by scale, we presented relevant findings concerning specific items to clarify or elaborate the category- and scale-level findings reported in Table 2.

At the highest level of generality, this synthesis confirmed the importance of the quality of schooling for

Table 2.—Reliabilities, Means, Standard Deviations, and Frequencies for Source Ratings

Category/subcategory	Reliability[a]	*M*	*SD*	Frequency
State and district variables	.90	1.22	.81	27
District demographics and marker	.95	1.46	.50	14
State-level policy	N.C.	1.24	1.00	19
Out-of-school contextual variables	.99	1.87	.39	59
Community	N.C.	1.80	.41	15
Peer-group	.98	2.00	.34	18
Home environment and parental support	.95	1.90	.40	47
Student use of out-of-school time	N.C.	1.94	.46	17
School-level variables	.95	1.54	.96	102
Demographics and marker	.91	1.74	.56	25
Teacher/administrator decision making	.87	1.65	.95	21
School culture	.87	1.84	.43	49
School-wide policies and organization	.76	1.40	1.14	74
Accessibility	N.C.	2.00	.00	2
Parental involvement policy	N.C.	1.67	.56	23
Student variables	.92	1.83	.57	155
Demographics and marker	.71	1.70	.77	90
History of educational placements	N.C.	0.16	1.80	19
Social and behavioral	.80	1.98	.34	35
Motivational and affective	.91	1.93	.42	81
Cognitive	.88	1.98	.33	101
Metacognitive	.91	2.08	.36	76
Psychomotor	N.C.	2.33	.52	6
Program design variables	.90	1.90	.38	142
Demographic and marker	N.C.	1.97	.54	23
Curriculum and instruction	.90	1.92	.46	108
Curriculum design	.89	1.88	.34	97
Classroom instruction and climate variables	.97	1.84	.66	165
Classroom implementation support	.85	1.84	.38	66
Classroom instructional	.89	1.85	.74	156
Quantity-of-instruction	.94	2.02	.64	69
Classroom assessment	N.C.	1.89	.30	61
Classroom management	.98	2.07	.23	42
Student/teacher interactions: social	.73	2.02	.41	44
Student/teacher interactions: academic	.77	1.89	.44	29
Classroom climate	.99	2.01	.38	75

[a] Coefficient alpha reliabilities were estimated for each scale from average variances and interitem covariances. Due to missing data, ratings for some cases are based on fewer items. Thus, obtained reliabilities are somewhat lower than the figures reported in this table. N.C. indicates values that were not calculable, either because scales consisted of only a single item or because of patterns of missing data.

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learning outcomes. Of the six categories, the highest ratings overall were assigned to Program Design Variables, followed by Out-of-School Contextual Variables. The category reflecting the quality of instruction as delivered, Classroom Instruction and Climate Variables, ranked third in importance, closely followed by Student Variables. The last two categories, School-Level Variables and State and District Variables, received markedly lower ratings overall. This overall ranking of sources of influence contrasted sharply with the "conventional wisdom" because the Equality of Educational Opportunity (EEO) Survey (Coleman et al., 1966) stated that quality of schooling has relatively little impact on schooling outcomes relative to out-of-school socioeconomic variables.

The importance of proximal psychological variables may be seen in the scales that obtained the highest ratings.[9] Those scales with mean ratings of 2.00 or greater (beginning with the highest) were:

Metacognition	$\bar{X} = 2.08$
Classroom management	$\bar{X} = 2.07$
Quantity of instruction	$\bar{X} = 2.02$
Student/teacher interactions: Social	$\bar{X} = 2.02$
Classroom climate	$\bar{X} = 2.01$
Peer group influences	$\bar{X} = 2.00$

In the remainder of this section, the categories and scales are discussed in turn, and those scales and items that received exceptionally high ratings are highlighted. The categories representing instruction as designed and instruction as delivered are discussed first. Those categories are followed by out-of-school context and student characteristics. Finally, the more distal variable categories of school level variables and state and district variables are addressed.

Program Design Variables

This category includes instruction as designed, and the physical arrangements for its delivery, organized into three scales, as shown in Figure 1 and Table 2. The scale Demographic and Marker Variables was rated highest of the three, and, within this scale, the most highly rated items are size of instructional group (whole class, small group, or one-on-one instruction), number of classroom aides, and resources needed. (Ratings for those items ranged from 1.95 to 2.00). Thus, the most important aspect of program design appeared to be the intensity of educational services provided to each learner. More aides, smaller groups, or increased material resources were associated with significantly higher learning outcomes.

Curriculum and Instructional Variables includes items with average ratings above 2.0 (moderate relation to learning). The highest rated of those suggest that the key to effective instructional design is the flexible and appropriate use of a variety of instructional strategies, while maintaining an orderly classroom environment. The highest overall rating in this scale was for use of . . . techniques to control classroom disruptiveness. This item was followed by use of prescriptive instruction combined with aspects of informal or open education and presence of information in the curriculum on individual differences and commonalities, both of which explicitly relate to student diversity and individualization. Other highly rated items referred to specific instructional strategies, including use of mastery learning techniques, . . . instructional cues, engagement, and corrective feedback . . . use of cooperative learning strategies, and use of diagnostic-prescriptive methods.

Curriculum Design also includes several items with average ratings near 2.0, although none exceeds the moderate level. High ratings were given to, materials employ alternative modes of representation and degree of structure in curriculum accommodates needs of different learners, both of which reinforce the importance of offering a variety of instructional materials and approaches to accommodate individual differences. The importance of the organization of curriculum content is revealed by two highest rated items in this scale, materials employ learning hierarchies and material is presented in a cognitively efficient manner.

Implementation, Classroom Instruction, and Climate Variables

This category includes support of the curriculum and the instructional program, classroom routines, specific instructional, assessment, and classroom management practices; quantity of instruction, academic and nonacademic student-teacher interaction, and classroom climate. By far the largest of the six categories, this group constitutes 79 of the 228 items and 8 of the 30 scales. Half of those scales had mean ratings above 2.00, placing them overall among the most influential scales.

High ratings in the areas of implementation, classroom instruction, and climate again highlight the importance of maintaining an orderly classroom environment and providing clear, well-organized instruction appropriate to the needs of individual learners. In the overall ranking of all 30 scales, Classroom Management ranked second, and its most critical items were group alerting (teacher uses questioning/recitation strategies that maintain active participation by all students) and learner accountability (teacher maintains student awareness of learning goals and expectations). Smooth transitions from one instructional activity to another, minimal disruptions, and teacher awareness of classroom activity at all times also received mean ratings above 2.00.

Quantity of Instruction was ranked third overall, following Classroom Management. This included scale time spent in direct instruction, especially direct instruction on basic skills, time spent on homework, and length of the

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school day and year. The importance accorded quantity of instruction is not surprising. This construct has appeared in many of the most widely cited models of school learning (Haertel, Walberg, & Weinstein, 1983).

Student/teacher interactions. Social ranked fourth overall, and Classroom Climate was ranked fifth. The high ranking for social interactions was almost entirely caused by two items with mean ratings of 2.00 or greater: teacher reacts appropriately to correct and incorrect answers and student responds positively to questions from other students and from teacher.[10] Classroom climate included 15 items with ratings of 2.00 or greater. Together, the highly rated items in those two scales characterize a classroom in which teacher and students interact considerately and cooperatively, where students work with several classmates, share common interests and values, and pursue cooperative goals. In that type of classroom, students are actively engaged in learning and are involved in making some types of classroom decisions. Concurrently, the class is well organized and well planned, with a clear academic focus. Objectives of learning activities are specific and explicit, and students feel continually and appropriately challenged, with the pacing of instruction appropriate for the majority.

The remaining scales under Implementation, Classroom Instruction, and Climate Variables had much lower overall ratings, but they included more than 20 specific items with means of 2.00 or greater. The majority of those items referred to instructional organization and to mechanisms for assuring that students understand that organization and the goals of instruction. For example, high ratings were given to the use of advance organizers and directing students' attention to the content to be learned, as well as to clear and organized direct instruction, systematic sequencing of lesson events, and clear lesson transitions. Other highly rated items included corrective feedback in case of student error, frequent academic questions, and accurate measurement of skills. Finally, the literature strongly supported the teaching of skills in the context of meaningful applications, use of good examples and analogies, and teaching for meaningful understanding, together with explicit promotion of student self-monitoring of comprehension and gradual transfer of responsibility for learning from the teacher to the student.

Extramural Variables

This category included items associated with the home and community contexts within which schools function. As presented above, Peer-Group Variables was ranked sixth among all scales. This ranking was primarily caused by the emphasis placed on peers' educational and occupational aspirations, both of which had mean ratings of 2.00 or higher.

Additional highly rated items in this category reflected parental interest and involvement in students' schoolwork. For example, parental involvement in assuring completion of homework, parental participation in school conferences and related activities, and parental interest in students' school work all received high ratings. The educational environment of the home (e.g., number of books and magazines) also was cited in numerous sources and received consistently high ratings. Student participation in clubs and extracurricular school activities and time spent on leisure reading also were moderately related to learning outcomes.

Student Variables

Student Variables items were associated with individual students themselves, including demographics, academic history, and various social, cognitive, and affective characteristics. Among those items, psychomotor skills specific to area instructed had the highest rating, which was 2.33. This item was the only one included in the Psychomotor Variables scale. However, as explained above, this mean was based on only six sources. This mean was best regarded as a statistical artifact and will not be further discussed.

Metacognitive Variables received the highest mean ratings of any of the remaining scales in the entire framework. Highly rated metacognitive items included comprehension monitoring (planning; monitoring effectiveness of attempted actions; testing, revising, and evaluating learning strategies), self-regulatory, self-control strategies (e.g., control of attention), and positive strategies to facilitate generalization of concepts.

Several specific items in the remaining Student Variables scales also had high ratings, including positive behavior and ability to make friends with peers, motivation for continual learning, annd perseverance on learning tasks. Highly rated items from the Cognitive scale included several representing general mental abilities, levels of basic skills sufficient to profit from instruction, and prior knowledge in the subject area instructed.

School-Level and State and District Variables

Educational policy items at the school, district, and state levels appeared from this research synthesis to have relatively little association with learning outcomes, as shown by low mean ratings for categories and scales. A few items in this area received mean ratings of 2.00 or higher, but nearly all of those were based on fewer than 10 sources. Nonetheless, several school-level educational practices emerged as important. Those practices included the presence of an effective schools program, explicit school grading, academic progress, and attendance policies, and a safe and orderly school climate. Peer and cross-age tutoring, which were classified as school-level variables when their implementation required coordination among self-contained classrooms, also received

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moderate or higher ratings based on discussions in more than 10 sources.

Discussion

This research synthesis confirms that distal policy variables are less important to schooling outcomes than quantity and quality of instruction, home environment, or student characteristics. Of the six categories in the conceptual framework (see Figure 1 and Table 2), State and District Variables and School-Level Variables, both comprising mainly policy variables, had markedly lower mean ratings than the remaining four categories. The items most important to learning outcomes were those that were directly tied to students' engagement with the material to be learned.

In contrast to the earlier view that quality of schooling is of little importance relative to out-of-school factors (Coleman et al., 1966), our synthesis also suggests that from kindergarten through Grade 12, across a range of content areas and educational contexts, quality and quantity of instruction are roughly equal in importance to student characteristics and out-of-school contextual items.

Furthermore, the present synthesis of educational research is considerably more comprehensive than *What Works: Research About Teaching and Learning*, the widely distributed pamphlet of the U.S. Department of Education (1986), and it contains both highly effective and relatively less-effective practices. The present synthesis, moreover, draws on a larger body of literature and contains a more explicit methodology that can be replicated by other investigators. This research contains some 228 practices in comparison with 41 in the original *What Works* (and 62 in the second edition), and it gives a numerical rating to each one as well as composites. Yet none of the findings of *What Works* and the present work are discordant. *What Works* contains specific findings and elaborates on and illustrates various techniques. Such techniques are described specifically enough to be understood by parents and teachers; perhaps they might even be put into practice without assistance.

Regarding the 30 scales, those identified as most important to good learning outcomes are student metacognition, effective classroom management, quantity of instruction, positive and productive student/teacher interactions, a classroom climate conducive to learning, and a peer culture supportive of academic achievement. Those broad conclusions are supported by more specific findings from the research synthesis. Those selected findings are highlighted below.

Student characteristics. Individual differences among students have long been recognized as critical determinants of learning outcomes, but we were surprised and encouraged that in this synthesis the metacognitive items emerged as most important, including comprehension monitoring, use of self-regulatory, self-control strategies, and use of strategies to facilitate generalization of concepts. Metacognitive variables are heavily cited in the current literature, in contrast to an earlier focus on relatively stable general mental abilities. A better understanding of those alterable variables may ultimately help the great majority of students to reach higher achievement levels through appropriate training in metacognition. Two additional student items accorded importance in the research literature are perseverance on learning tasks and motivation for continual learning. Both of those factors reinforce the conclusion that consistent engagement with the subject matter to be learned is critical to school success.

Quality and quantity of instruction. Classroom management and climate and student-teacher interactions represent an important constellation of variables related to effective instruction. Detailed examination of the highly rated items in those areas reveals a portrait of cooperative, cohesive, goal-directed classrooms, in which a variety of educational approaches and activities are employed. Items heavily cited in the research literature include sound organization and systematic sequencing of instruction and effective use of direct, teacher-centered instruction. Among other instructional approaches frequently linked to positive learning outcomes are peer and cross-age tutoring and cooperative group-learning strategies.

Several items associated with quantity of instruction also emerged as important, including student time on task, length of school day and year, amount of time allocated to direct instruction in basic skills, and time spent out of school on homework and on leisure reading. Of these variables, the most frequently cited one is time on task. These time-related variables have clearly become well established and widely accepted as determinants of learning outcomes, in spite of criticims cited by Shulman (1986) of time as an "empty vessel."

Out of school context. Researchers are giving increasing attention in the research literature to the role of parental involvement and support variables in promoting student learning. The synthesis affirms the importance of those items, as well as peer-group influences. Those findings are reflected in ratings for parental involvement in school activities, interest in schoolwork, and monitoring of school attendance and homework completion. Parental support might also be mediated through influence on students' selection of friends. Peer group variables, especially academic and occupational aspirations, are strongly related to school success.

Strength of influences on school learning. Physical processes can often be explained as functions of a small number of variables interacting in simple ways. In contrast, schooling processes respond to a multitude of influences interacting in kaleidoscopic patterns. This research synthesis has confirmed that a large number of variables are moderately related to learning outcomes, but few, if any, single variables are strongly related to learning. Authors of original research studies and of reviews and syntheses are appropriately cautious in stating the importance of particular items, and their caution is reflected in the relatively narrow range of mean ratings presented in Table 2. Nonetheless, taken together, the items examined in this synthesis are powerful determinants of school effects.

NOTES

1. This research was supported in part by the Temple University Center for Research in Human Development and Education and in part by a grant from the U.S. Department of Education's Office of Special Education and Rehabilitative Services. The opinions expressed herein are solely those of the authors, and no official endorsement should be inferred.
2. Copies of the detailed coding form and complete bibliographic citations for the 179 sources, as well as copies of the data archive, are available from Margaret C. Wang, Center for Research in Human Development and Education, Ritter Hall Annex, 9th Floor, Temple University, Philadelphia, PA 19122.
3. In addition to the coding and analysis of the 179 source documents, a survey also was conducted of the authors of all major source documents examined. The summary coding form described below was distributed to authors, with a request to provide overall ratings of the importance of the 228 items to learning outcomes. A total of 78 forms were returned. Those expert ratings were analyzed separately from the source document ratings, following identical procedures. Results were highly similar, with the exception that the experts generally tended to give somewhat higher numerical ratings.
4. This panel included 12 prominent experts in areas of research on teaching, education, educational psychology, and special education.
5. Most of those occurred for items in the scale History of Educational Placements, which accounts for the low mean of this variable in Table 2.
6. If any supplementary items had been coded, those were reexamined as the forms were transcribed and, whenever possible, were included under one of the prespecified items. This procedure was generally possible because most supplementary items documented authors' more detailed or specific empirical conclusions, for example, specific types of motivation related to learning or particular variants of instructional practices. Such detailed findings were incorporated into the broader variable prespecified on the form. The other supplementary items were those documenting two-way or occasionally higher order interactions. Because interactions represent more subtle findings and frequently fail to replicate, they were not transferred from the detailed form to the summary form. The summary forms were keyed and verified, and files were prepared for data analysis using standard statistical software packages.
7. The weights used were equal to the numbers of original items included in the respective scales. Note that if there were no missing data, this procedure would result in giving all of the original items in a broad category equal weight. Where some items in a scale are missing, this procedure in effect assigns the mean of the nonmissing scale items to those missing observations. For any given scale, about 15% of the values of items on average were missing.
8. As noted in the footnote to the table, those reported reliabilities are for means of all the items in a given category or scale. Due to missing data, values for some sources were based on means of fewer items.
9. The highest ratings overall were assigned to Psychomotor Variables and a moderately high rating also was assigned to the scale Accessibility Variables. However, only one item was included in each of those scales, and those items were referred to in 6 or fewer of the 179 sources analyzed. Thus, Psychomotor Variables and Accessibility Variables were set aside. The list of scales with the highest ratings include the 28 scales with more items and ratings.
10. A third item in this scale, teacher provides explicit coaching to reduce aggression, also received a mean rating above 2.00 but was mentioned in only 4 of the 179 sources. That item is of limited relevance in most regular educational settings.

APPENDIX

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Subject-Area Learning

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Revising social studies text from a text-processing perspective: Evidence of improved comprehensibility

THE PURPOSE of the present study was to use a cognitive processing perspective to revise fifth-grade social studies texts, to describe those revisions, and to demonstrate their effects empirically. Four segments of text from a U.S. textbook about the period leading to the American Revolution and their revised counterparts were presented to 85 fourth- and fifth-grade students. Students were presented with the text materials in individual sessions with an examiner and were asked to recall what they had read and to answer questions on the material. Students who read the revised text recalled more material and answered more questions correctly than students who read the original text. Differences in understanding between the two groups were also captured in qualitative analyses of recall protocols and question responses related to specific ideas in the text. Overall, the effects of the revisions demonstrate that a text-processing approach to creating comprehensible text is a viable one. Furthermore, the description of revision goes beyond how revisions have been described in past research by exposing the reasoning underlying the identification of problems and the changes made.

Amélioration de la compréhensibilité des textes en sciences humaines: Elaboration de critères de revision fondés sur les modèles cognitifs de traitement des textes

LE BUT DE LA présente recherche était d'appliquer la perspective des modèles cognitifs de traitement des textes à la revision de textes extraits de manuels scolaires en sciences humaines du niveau de cinquième année primaire. La recherche a porté sur quatre extraits d'un livre d'histoire traitant de la période qui a conduit à la révolution américaine. Les versions originales des quatre textes et les versions revisées ont été présentées à 85 élèves de quatrième et de cinquième année au cours de sessions individuelles; les sujets devaient produire un rappel des textes et répondre à des questions de compréhension. Les élèves qui ont lu les versions revisées ont rappelé davantage d'informations et ont répondu à davantage de

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questions que les sujets qui ont lu les versions originales. Des analyses qualitatives appliquées à la fois sur les rappels et sur les réponses aux questions de compréhension ont permis de mieux saisir les différences de compréhension. En général, les résultats ont confirmé l'intérêt d'appliquer un modèle de traitement cognitif des textes pour améliorer la compréhensibilité des textes. La présente recherche décrit explicitement le rationel qui motive les améliorations apportées, la façon d'identifier les problèmes et la nature des changements apportés.

Revisando un texto de estudios sociales desde una perspectiva de procesamiento de textos: Evidencia de mejora en la comprensión

EL PROPÓSITO del presente estudio fue usar una perspectiva del procesamiento cognitivo para revisar los textos de quinto grado de estudios sociales, describir esas revisiones, y demostrar sus efectos empíricamente. Cuatro segmentos de textos de un libro de texto acerca del periodo anterior a la Revolución norteamericana fueron revisados. Se presentaron los segmentos originales y las versiones revisadas a 85 estudiantes de cuarto y quinto grados en sesiones individuales; se pidió a los estudiantes que recordaran lo que habían leído y que contestaran preguntas sobre el material. Los estudiantes que leyeron el texto revisado recordaron más material y contestaron más preguntas correctamente que los estudiantes que leyeron el texto original. También se identificaron diferencias en la comprensión en los dos grupos en análisis cualitativos de protocolos de recuerdo y respuestas a preguntas relacionadas con ideas específicas en el texto. En general, los efectos de las revisiones demostraron que un acercamiento de procesamiento de texto para crear un texto comprensivo es una aproximación viable. La investigación actual describe explícitamente la razón para cada revisión hecha—cómo se identificó cada problema, y qué cambios fueron hechos para enfrentar ese problema.

Landeskundliche Texte aus Sicht einer textverarbeitenden Perspektive revidieren: Belege für eine verbesserte Verständlichkeit des Textes

ZWECK DIESER STUDIE war es, Forschungsergebnisse im Bereich der kognitiven Verarbeitung anzuwenden, um landeskundliche Texte des fünften Schuljahres zu revidieren, diese Bearbeitungen zu beschreiben und deren Wirkungen empirisch nachzuweisen. Aus einem amerikanischen Lehrbuch wurden dazu vier Textabschnitte, die die Zeit vor der Amerikanischen Revolution behandelten, revidiert. Die Originalabschnitte und die revidierten Fassungen wurden 85 Schülern des 4. und 5. Schuljahres vorgelegt. Beide Male wurden die Abschnitte im Einzelunterricht präsentiert und die Schüler dazu aufgefordert, das Gelesene nachzuerzählen und Fragen zum Material zu beantworten. Die Schüler, die den revidierten Text gelesen hatten, konnten mehr Informationen nacherzählen und mehr Fragen richtig beantworten als die Schüler, die den Originaltext gelesen hatten. Die Unterschiede im Verständnis zwischen den beiden Gruppen wurden außerdem anhand von qualitativen Auswertungen der Nacherzählungen und Antworten auf die Testfragen, die sich auf bestimmte Ideen des Textes bezogen, festgehalten. Im ganzen zeigen die Auswirkungen der Revisionen, daß ein textverarbeitendes Verfahren beim Aufstellen von Verständnistexten sinnvoll ist. In der vorliegenden Studie werden die Grundprinzipien jeder einzelnen Revidierung besprochen: wie jedes einzelne Problem identifiziert wurde und welche Anderungen zur Behebung des jeweiligen Problems in Angriff genommen wurden.

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Revising text for comprehensibility BECK ET AL.

The quality of school textbooks has long been of concern to professionals in many areas of educational research and practice. One way this concern has been expressed is in attempts to provide students with "comprehensible" texts, which have traditionally been manifested through the application of readability formulas. These formulas are based on simple indices, such as sentence and word length, that correlate with text difficulty, but do not account for what makes a text easier or more difficult to comprehend (Kintsch & Vipond, 1979).

Recently, cognitive theorists and reading researchers have gone beyond the conception of comprehensibility as simply vocabulary difficulty and sentence length, and have begun to describe text features that influence comprehension directly, by considering how readers construct a cognitive representation of incoming information. Such a cognitive perspective, with its emphasis on the mental activities involved in reading, has yielded an understanding of reading as a complex process in which a reader constructs meaning by integrating perceptual, linguistic, and conceptual information from the text with his or her own knowledge base (see, e.g., Graesser & Clark, 1985; Just & Carpenter, 1987; Kieras, 1985; Perfetti, 1985; Rumelhart, 1980; Trabasso, Secco, & van den Broek, 1984; van Dijk & Kintsch, 1983). Cognitive reading research seems a natural backdrop for research involving the development of comprehensible texts because it explicitly considers processes such as the interaction of a reader's knowledge with the way in which the text is presented. This process orientation provides more access points from which to consider reader/text interactions and the places where they may break down.

Although recent cognitive theory and research would seem to have clear applications for producing more comprehensible texts, these notions have not yet been applied directly in the development of textbook discourse. Hence, a major motivation for the present study was to apply understandings gained from cognitive theory and research to the revision of text presented in elementary social studies textbooks and to determine the effectiveness of the revisions.

Focusing on the processes involved in reader/text interactions provided the means to pursue an additional goal in the present study, which was to expose the reasoning underlying revisions made to the texts. In past research on text, the creation of revisions that improve comprehension has met with some success. However, communicating the thinking that motivated the revisions has proved to be a more intractable problem. The descriptions of the revisions made to improve text comprehension have most frequently been global and intuitively obvious, such as "clarifying the content by highlighting main ideas," "adding cohesive ties," "providing background information," "deleting irrelevant information," and "clarifying the structure" (Beck, McKeown, Omanson, & Pople, 1984; Britton, Van Dusen, Gulgoz, & Glynn, 1989; Duffy et al., 1989; Graves et al., 1988). Although most people would agree that such descriptions characterize more comprehensible discourse, these descriptions in themselves do not serve to explain why and how specific revisions were made. The general nature of these descriptions of revisions may have been sufficient for the aim of the studies in which they were developed, which was to examine the effects of text revisions on comprehension, rather than to communicate why various text features might cause difficulty and how to approach solutions. But such general statements cannot effectively guide the creation of more comprehensible text.

In addressing the problem of how to describe revisions in more effective ways, Duffy et al. (1989) suggest that what is needed is a library of examples of text problems and their solutions. Although we believe that this notion is certainly a step in the right direction, it does not go far enough. Sets of examples need to be accompanied by in-depth descriptions of the process of getting from the original to the revision—that is, the identification of problematic aspects of the original text and their potential effects on target readers as well as potential solutions to the problems and explanations for why such solutions might work.

Britton et al. (1989) suggest that this type of in-depth description of the reasoning behind the revision process may be difficult to obtain. They examined the revisions made by five sets of revisers, the effects of the revisions on comprehension, and the rationales the revisers gave for making the revisions. Britton et al. concluded that, although a majority of the revisers made effective revisions to texts, they were less able to describe the kinds of changes they made and what motivated the changes.

The reasoning that underlies successful revisions is a rich resource that remains untapped. Exposing this reasoning might provide greater access to an understanding of why some textual features are problematic and a more detailed conception of what characterizes comprehensible text. Thus, it was our intention to capture and articulate the thinking that went into the identification of potential problems and the development of solutions.

The approach we have taken coincides with recommendations that Britton et al. (1989) developed for moving toward more effective descriptions of revisions. They suggested that educational psychologists should develop expertise in revising, to which they can then apply their "well developed vocabulary and store of relevant concepts about language, cognitive processes, and teaching" (p. 13) toward making knowledge of the revising process explicit.

Thus, the goals of the present study were (a) to make revisions in a sequence of textual materials from a fifth-grade social studies textbook based on a cognitive processing perspective, (b) to describe the theoretical motivations for those revisions, and (c) to demonstrate the effects of the revisions empirically by examining students' comprehension of the original and revised materials.

A text-processing approach to revision

The aspects of cognitive theory and reading research that guided the revisions focused on the complexity of the processes involved and on attributes of texts that can cause people difficulty in the course of reading. According to a cognitive text-processing view (see, e.g., Just & Carpenter, 1987; Perfetti, 1985), as a reader moves through a text, he or she encodes explicit text information and combines it with knowledge of word meanings and language conventions, knowledge about the form of texts, and general knowledge related to the content. The reader must identify each new piece of text information and decide how it relates to information already given (see Clark, 1977; Clark & Haviland, 1977). As reading proceeds, the reader forms a representation of the text's message and continuously updates it as subsequent text information is encountered. The representation is formed by drawing connections both between outside knowledge and text information and between given and new text information. If the reader fails to bring knowledge to bear on the text, or if features of the text inhibit the reader's ability to make connections between given and new information, comprehension may be impeded.

A reader's failure to bring appropriate knowledge to bear may arise from lack of specific knowledge of word meanings (Beck et al., 1987; Omanson, Beck, McKeown, & Perfetti, 1984), lack of knowledge related to the topic (Beck, Omanson, & McKeown, 1982; Pearson, Hansen, & Gordon, 1979), or from failure to recognize that particular knowledge is relevant to the text and needs to be accessed (Anderson, Reynolds, Schallert, & Goetz, 1977).

The failure of a text to assist a reader in making connections may be the result of particular text features, such as the use of references that are ambiguous (Frederiksen, 1981) or distant (Cirilo, 1981; Lesgold, Roth, & Curtis, 1979) or indirect (Haviland & Clark, 1974; Just & Carpenter, 1978), the failure to provide information that allows a reader to activate an appropriate context for the text content (Anderson, 1978; Bransford & Johnson, 1973; Kieras, 1985), the lack of clear connections between events (Black & Bern, 1981; Kintsch, Mandel, & Kozminsky, 1977; Stein & Nezworski, 1978), the inclusion of irrelevant events and ideas (Schank, 1975; Trabasso et al., 1984), or the introduction of a high density of concepts

(Kintsch & Keenan, 1973; Kintsch, Kozminsky, Streby, McKoon, & Keenan, 1975).

Our approach to revisions involved an attempt to simulate the process of the interaction between a reader—in this case, a 10-year-old—and a text. Thus, texts were evaluated by considering how each new piece of text information might be handled, the kind of knowledge that the reader would need to bring to bear, and how the developing text representation would be influenced. We hypothesized the points at which the process might break down (e.g., where requisite background information might be lacking or where a referent might be difficult to track), and ways in which an ideal reader might repair such breaks. These potential repairs were used as the basis for the revised version of the text. As we considered what might happen within a 10-year-old reader's comprehension process, we switched back and forth between (a) hypothesizing what the student might be thinking, (b) considering what seemed to be intended by the text, and (c) constructing text statements that might bring about understanding of the intended meaning for the target reader.

Method

Subjects

The subjects for this study were 40 fifth-grade and 45 fourth-grade students drawn from two elementary schools in a small, middle-class public school district in the northern United States. All students in both grades were invited to participate. Parental permission was received for 95 percent of the fifth-grade and 82 percent of the fourth-grade students. All students for whom written permission was received were included as subjects.

National percentile rank scores were obtained for both the fourth- and the fifth-grade students on reading comprehension from the Metropolitan Achievement Test (Prescott, Balow, Hogan, & Farr, 1984). These scores were comparable across grade levels because both groups' Metropolitan Achievement Test scores were obtained from tests administered during the month of March in each student's fourth-grade year. The mean comprehension score was 63.3 (SD = 21.9) for fifth-grade and 60.1 (SD = 22.7) for fourth-grade students.

The original text materials were presented to the fifth-grade students in November; the revised materials were presented to the fourth-grade students in May of the same school year. The fifth-grade students had to be tested in November because they had just completed the chapter in their social studies textbook about the exploration and colonization of North America and were ready to begin the chapter from which the materials in this study were drawn. From that point on in the school year, it was no longer possible to use these materials with fifth-grade subjects because the content would have already been covered in their classes. Thus, the revised materials were presented to fourth-grade students late in the school year.

Materials

The materials for the study included a sequence of four passages drawn directly from a fifth-grade social studies textbook (Silver Burdett, 1984) and a revised version of each of those passages. Each passage dealt with an event or issue that was central to the development of the American Revolution. The topics covered were (a) the French and Indian War, (b) the issue of "no taxation without representation," (c) the Boston Tea Party, and (d) the Intolerable Acts.

The text revisions made in the present study were rooted in an analysis of current elementary social studies textbooks recently completed by Beck, McKeown, and Gromoll (1989). That analysis suggested that the texts presented in many social studies textbooks, including those used in the present study, were likely to be problematic for students' learning of the intended content.

Revised text

In this section we discuss our goals in revising the passages under consideration and present in detail the revisions made to the passage on the French and Indian War. Because of space limitations, the revisions made to the three subsequent topics will only be summarized.

Goals. The general goal of the revisions was to create a text that would assist a reader in connecting pieces of text information and combining that information with knowledge to develop a coherent text representation. To meet this goal, the revised text was based on a causal sequence of events leading to the Revolution, and presented the information in such a way as to expose the reasoning that connects a cause to an event and an event to a consequence. This type of presentation is what we have termed a *causal/explanatory* style (Beck et al., 1989).

The content goal that we inferred from the original textbook sequence was to provide an initial understanding of some of the major events leading to the American Revolution. This goal, and the topics that the textbook authors had selected to achieve this goal, were maintained in the revision. These aspects of the original presentation were maintained because we viewed the sequence of topics presented in the textbook to be reasonable in that it contained sufficient raw material to create a coherent sequence of how and why the Revolution occurred.

The goal of creating a causal/explanatory text based on this sequence was, however, constrained by experimental concerns. That is, because the purpose of the study was to compare students' comprehension of the original and revised versions, a primary consideration was to maintain a common core of content on which to base our evaluation of student understanding. An additional concern was that the revised text not be excessively longer than the original. Although the inclusion of causal/explanatory material did necessitate some increase in length, only the content common to both texts was scored.

Revisions to the passage on the French and Indian War. Most U.S. history books, including high school and college texts, as well as three of the four elementary texts analyzed in the earlier study (Beck et al., 1989), describe the chain of events that led to the American Revolutionary War as having begun with the French and Indian War. The connection between the French and Indian War and the Revolution was that, as a result of the French and Indian War, several sources of tension developed between the British and the American colonists. In particular, the cost of the French and Indian War left Britain in poor financial condition. In order to defray the cost of the fighting, the British Parliament chose to tax the colonists. In the colonists' view, such taxes were not legitimate. Thus, a consequence of the war—the imposition of taxes—became an important initiating event in the conflict between Britain and the colonies.

Given that initiating events of the Revolution are anchored in a consequence of the French and Indian War, in order to set in motion the sequence of events that led to the American Revolution, students need to know that this war existed. But, in terms of the established instructional goal, they do not need to understand details of issues and events of the French and Indian War itself. It seems that the authors of the original text had three major goals in describing the French and Indian War: (a) establishing that the French and Indian War happened, (b) noting the colonists' perspective on the outcome of the war, and (c) foreshadowing the American Revolution. These are reasonable purposes that can capture what young students need to know about the French and Indian War in order to connect it to the sequence of events that led to the Revolution. We found the text lacking, however, in meeting these minimal purposes.

The general operations used in making revisions were clarifying, elaborating, explaining, and providing motivation for important information, and making connections explicit. However, in the description that follows we go beyond other descriptions of revisions by providing instantiations of these general heuristics in the form of process-annotated examples that tie research findings to the identification of text problems and formulation of solutions. Because we view the development of revisions as inextricably intertwined with the particular content, our analysis of each sentence or set of related sentences of the original text (O) and the solutions to the problems as manifested in the revised text (R) are presented.

The first sentence in the original text was the following:

> (O1) In 1763 Britain and the colonies ended a 7-year war with the French and Indians.

We judged this sentence as potentially problematic for young readers because of two features. First, as an introduction to the French and Indian War, it begins in the wrong place – the end of a war that has not previously been mentioned – and thus breaks the given/new contract (Clark, 1977; Clark & Haviland, 1977). Second, this sentence is extremely information-dense. Many concepts are communicated in relatively few words, a situation that can inhibit comprehension (Kintsch & Keenan, 1973; Kintsch et al., 1975).

We judged that the authors of this text intended for sentence O1 to impart the information that (a) the French and Indian War existed, (b) this war lasted 7 years, (c) it ended in 1763, (d) the British and their American colonists fought together on one side, and (e) the French and the Indians fought on the other side. The density of the information means that much has been left implicit. Of the five pieces of information, only the duration of the war and the date it ended are stated directly. Thus, the reader must make many inferences to construct the remaining information from the text. For example, the reader must use the phrase "ended a war" to construct the simple fact that a war occurred.

Moreover, none of the information is elaborated or explained in a way that would allow a reader to connect the information to previous text concepts or to prior knowledge. This lack of connection becomes particularly problematic if the reader does not know who was fighting whom. One question that such a reader might have is why Britain and the colonies would be on the same side in a war. For this information to make sense, a young reader would need to know that the colonies belonged to Britain at the time; with this information, the reader might be able to reason that the colonies would be allied with the mother country. But there is evidence that many students lack this prerequisite knowledge (McKeown & Beck, 1990), so they would not be able to engage in such reasoning. A second question that might arise is why the French and Indians would be on the same side; readers who do not know the answer to this question cannot construct it from information presented previously in the text. A third possible source of difficulty is that the text does not clarify that Britain and France were the main parties in the conflict, and does not give any reason for their antagonism.

In the revision, seven sentences were needed to resolve all the issues left incomplete in the original text's initial sentence. It took seven sentences primarily because, in order to supply the missing connections, the revision was cast in narrative form to replace the static description of the original text. (We note that there was only one other instance across the four passages where this much material was required to resolve problems.) The sequence of events developed in the revised version was based on a set of agents and their actions, their goals, and the consequences of their actions (see, e.g., Stein & Trabasso, 1982), because those elements seem to represent the obvious minimal slots in a war schema. The first seven sentences in the revised version are presented below:

> (R1) About 250 years ago, Britain and France both claimed to own some of the same land, here, in North America. (R2) This land was just west of where the 13 colonies were. (R3) In 1756, Britain and France went to war to see who would get control of this land. (R4) Because the 13 American colonies belonged to Britain, the colonists fought on the same side as Britain. (R5) Many Indians fought on the same side as France. (R6) Because we were fighting against the French and Indians, the war has come to be known as the French and Indian War. (R7) The war ended in 1763.

The major aims of sentence R1 are providing a setting that motivates the war and establishing the primary agents who will be involved in the ensuing actions. It is such contextual or "setting" information that allows for interpretation of subsequent information (Stein & Trabasso, 1982). Stating that *Britain and France both claimed some of the same land* was intended to activate a "conflict" schema in a reader's mind – that when two parties claim the same thing, there could be trouble. Activation of a relevant schema can promote appropriate reader expectations, which then allow a reader to draw relationships between pieces of information more readily (Anderson, 1978; Kieras, 1985).

We replaced the date that appeared in the original sentence *(1763)*, with the wording *about 250 years ago;* our intent was to frame the events in a "long time ago" setting with a general statement that is probably more easily encoded by young readers than a specific year. In addition to setting the time, sentence R1 also sets the place: *here, in North America.*

There were two reasons we included sentence R2, which elaborates the location of the disputed land as *just west of the 13 colonies.* First, the wording keeps *the colonies* active for the reader, which is important because they constitute one of the two major agents of the actions described throughout the four passages. Second, the sentence was designed to confront a misconception found in earlier work (McKeown & Beck, 1990) among subjects of this age, who often seem to think that the French and Indian War was fought over ownership of the 13 colonies, and that Britain acquired the colonies as a result of that war. Sentence R2 explicitly places the disputed land beyond the colonies.

The purpose of sentence R3 was to describe the action taken to attempt to resolve the dispute between Britain and France. It does so by directly stating that there was a war and reinstating from sentence R1 the reason for the war and the major disputing parties.

Sentence R4 not only directly places the colonies on the same side as Britain, but also provides the reason that the colonies would be on Britain's side, in an attempt to make that partnership meaningful rather than an unconnected fact. The *Because...* phrase that provides a reason for the colonists' alignment with Britain was placed in the initial position in the sentence to signal the reader that a connection would need to be made. It has been shown that making such signals explicit has the potential to enhance comprehension (Marshall & Glock, 1978; Spyridakis & Standal, 1987; Zinar, 1990).

The purpose of sentence R5 was merely to establish that the Indians fought on the same side as France and thus enable the explanation in sentence R6 about why the war has this peculiar name when it was not a war between the French and the Indians. Such an explanation is warranted by the use of the war's name as a heading in the original text. We note that there is a deliberate inconsistency in our choice to include in the revision an explanation of the alignment of the colonies with Britain, but not the alignment of the Indians with France. The latter was not provided because the explanation is quite complicated and seemed more likely to disrupt coherence of the passage than to help the reader, in view of the tangential role of the missing information for the topic at hand and for the overall topic of the passages.

The apparent inconsistency in our inclusion of explanatory information is an apt example of situations in which issues in a text that seem alike on the surface do not necessarily warrant like treatment. In one case, a relationship between allies was made explicit in order to promote understanding of that relationship and thus of the text as a whole. In the other case, a similar relationship was left implicit because understanding of the relationship was not necessary for the content goal established and might even prove distracting for young readers. Inclusion of information that is not directly related to the topic can interfere with comprehension (Schank, 1975; Stein & Trabasso, 1982).

Finally, sentence R7 was included simply to close the French and Indian War sequence in order to set the stage for discussion of the consequences of the war that were relevant to the Revolution. At this point in the revised text, all issues from sentence O1 have been resolved.

We now consider the original text's description of the results of the war, which was presented in the following two sentences:

> (O2) As a result of this war France was driven out of North America. (O3) Britain would now rule Canada and other lands that had belonged to France.

The initial problem with this sequence is that the phrase *as a result of this war* is likely to lead readers to expect that the winner of the war will be named. Instead, the text goes on to present the loser, combined with the potentially unfamiliar language convention *driven out of North America*. This language may fail even to communicate the intent of the sentence—that France lost the war—much less help students infer that Britain won. Yet Britain's victory, and its effect on the colonies, is much more significant than France's loss for the purposes of setting the stage for pre-Revolutionary conflict.

The revised sentences about the results of the war appear below:

> (R8) Britain won the war. (R9) Now Britain had control of North America, including Canada. (R10) The French had to leave North America.

Sentence R8 states directly that *Britain won the war* to fill what was assumed to be an important slot in young children's war or conflict schema: a "winner." With the winner established, sentence R9 tells what was gained from winning. This statement serves to bring closure by resolving the conflict begun in the first sentence—that Britain and France were in a dispute over land. Research on the role of a narrative schema in comprehension supports the importance of providing a resolution to a conflict that has been set up in a text (see Stein & Trabasso, 1982). Sentence R10 then states what happened to the French, in language that is more likely familiar to young readers than that used in sentence O3.

Next, the original text discusses the effects of the outcome of the war on the colonists:

> (O4) This brought peace to the American colonies. (O5) The colonists no longer had to fear attacks from Canada.

These sentences present solutions to problems that have not been established. That peace has now befallen the colonies may puzzle young readers, as it implies a contrast, but the contrasting situation has never been presented. The same is the case for relief from attacks from Canada: The statement treats the colonists' fear of attacks as given information, but it has not been presented in the text. Thus, the reader encounters new information, but does not have the given information in memory to which it can be connected.

The revised text's discussion of the effects of the outcome of the war on the colonists takes into consideration the role of given and new information in comprehension (Clark, 1977; Clark & Haviland, 1977) by including the information that should have been given:

> (R11) The colonists were very glad that Britain had won. (R12) They now felt safer in their homes. (R13) Before the war, Indians had often attacked colonists who lived near the borders. (R14) Now Britain owned these lands where the Indians lived. (R15) The colonists were sure that Britain would protect them.

After the colonists' reaction to the outcome of the war is presented in sentence R11, sentences R12 through R15 explain why the colonists were pleased by elaborating the situation that existed before the war and how the war's outcome had ameliorated that situation. Thus, the revised sequence explains the situation referred to in sentence O5. The introductory words *Before* in sentence R13 and *Now* in sentence R14 were included as explicit signals, in this case to help readers establish temporal sequence.

The next section of the original text foreshadows the Revolutionary war:

> (O6) The Americans were happy to be part of Britain in 1763. (O7) Yet a dozen years later, these same people would be fighting the British for independence, or freedom from Great Britain's rule.

That there would be a change in the positive attitude expressed in sentence O6 must be inferred from the word *Yet* that begins sentence O7. In our revision of these sentences, we again took account of the demonstrated importance of explicating the relationships between key pieces of information, and provided a direct statement of the change that was to occur:

> (R16) The colonists were happy to be a part of Britain, but that was about to change. (R17) They began to decide that they would rather have their own country, independent from Britain.

Sentence R16 forecasts that the colonists' positive attitude *was about to change*. Sentence R17 then provides an explanation of what motivated the change. It is the colonists' motivation of wanting to have their own country that provides a context for the major issue of the subsequent topics. This revision is another reflection of the importance of supplying a context that will allow a reader to interpret subsequent information.

The final portions of the original and revised texts were as follows:

> (O8) This war was called the War for Independence, or the American Revolution. (O9) A revolution changes one type of government or way of thinking and replaces it with another.
>
> (R18) So a dozen years later, the colonists would be fighting the British for freedom from Great Britain's rule. (R19) This later war would be called the War for Independence, or the American Revolution.

The word *So* in the initial position in sentence R18 is another explicit connector, which was provided in this case to help the reader relate the motivation described in sentence R17 to the upcoming fight. In addition, in place of the vague referent in sentence O7 to *these same people*, sentence R18 states explicitly that it is *the colonists* who will be fighting the British. Sentence R19 uses the phrase *this later war* and the subjunctive future tense *would be called* to help young readers distinguish between the upcoming war for independence and the topic of the foregoing text, the French and Indian War. These changes are supported by Frederiksen's finding that young readers need greater lexical and semantic explicitness (1978), and by Lesgold et al.'s study of the usefulness of certain text mechanisms for referring to previously given information (Lesgold et al., 1979). In revising the final sentence in this passage, we decided to omit the definition of *revolution*, as we believed that any attempt to define it was likely to be unsuccessful in communicating the concept, which in any case was not necessary to understand the central concepts in the passage. (For ease of comparison, the original and revised versions of the French and Indian War text appear in their entirety in the Appendix.)

"No taxation without representation." For the three remaining passages, our analyses of the goals of the text, the presentation of the message, and the effectiveness of communicating that message to young students were similar to those described for the passage on the French and Indian War. We then used the same perspective described above to create revisions that would alleviate the problems identified. We will not present the details of those revisions, but we will summarize our revisions to these passages.

The section of the text on the topic of "No taxation without representation" describes Britain's taxation of the colonies after the French and Indian War, and the colonists' opposition to that taxation. Understanding why the colonists found taxes to be such an important issue is crucial in the development of the chain of events that brought about the Revolution. And such an understanding requires that students have some notion of what it means to be represented in a government body. The problem with the original text is that the discussion of representation is virtually devoid of explanatory power.

The notion that the colonists did not have representation regarding taxation has two roots: (a) that they could not vote for members of Parliament, and (b) that the colonial assemblies, which were elected by the colonists, had no voice in British taxation policies. In the original text, an understanding of these two issues would have to be constructed from the following sentences:

> (O1) The British lawmaking body was and still is called Parliament. (O2) The colonists were not members. (O3) The British started passing laws to tax the colonies.... (O9) The colonists got very upset about these taxes. (O10) Their own colonial assemblies had not voted for them. (O11) They did not welcome Parliament's tax laws.

For students to understand the representation issue, they would have to interpret sentences O1 and O2 to mean that Parliament was an elected body, but that the colonists could not take part in these elections. They would need to interpret sentences O10 and O11 to mean that the colonial assemblies, as the colonists' elected governmental bodies, had no say in determining British tax policy, and that therefore the colonists did not feel that they had to follow British tax laws. It was our judgment that readers would be unable to make either interpretation because the presentation of these issues is so brief and opaque.

For the revised text, we chose to focus solely on the colonists' lack of a voice in Parliament's decisions, because we saw it as a more direct path to understanding what the colonists meant by "No taxation without representation." Thus, the major revision we made in this section was to develop the following explanation, in which representation is described as *having a say* in what the government does:

> ...[T]he British Parliament made the tax laws that the colonists had to follow, but the colonists did not have any say in deciding them. "Having a say" in making the laws means that you decide, by voting, for the people who make the laws. The people who are elected to make the laws are called *representatives*. The problem was that the colonists were not allowed to vote for the people who made the laws, so they had no representatives in Parliament. When elections were held in Britain, only the people over in Britain voted. The colonists felt that since they could not vote for the people who make the laws, they should not have to follow the laws. So their motto became "No taxation without representation."

This revision focused on the explanation of the issue of having a say in government and how that issue was connected to the colonists' reaction to the taxes. In addition, a variety of small changes were made to establish local coherence.

The Boston Tea Party. The information this passage provides is that (a) the British kept a small tax on tea, (b) the colonists were angry about the tax and boycotted British tea, and (c) even after Parliament lowered the price of tea, the colonists refused to buy it and responded with protests, one of which was throwing tea from a ship in Boston Harbor. The original text presents all of the actual events, but the motivations for those events and how they relate to one another are conspicuously absent. For example, the text does not make explicit that, even after the price of tea was lowered, the tax on the tea remained.

Most of the revisions for this passage thus involved explaining and providing motivations for actions and reactions, and explicitly connecting causes to events and events to consequences. For example, in the revised version the colonists' anger over the tax is portrayed explicitly as the cause of their refusal to buy tea, which in turn was presented as the motivation for the British government's reduction in the price of tea. That the tax remained despite the lower price was stated and discussed as the cause of the colonists' strong reaction to the new situation. As an illustration of the implementation of these connections, consider the following excerpts from the original and the revised texts:

> *Original:* Boatloads of tea were sent to America. Since it was cheaper than ever, the British thought that surely the colonists would buy tea now! They were wrong. Tea was burned. Tea was left to rot.
>
> *Revised:* Since it was now cheaper than ever, the British thought that surely the colonists would buy tea! So they sent boatloads of it to the colonies. But, because the tea still had the tax on it, the colonists were as angry as ever. To show their anger, the colonists burned some of the tea. They left some to rot.

Thus, the revisions in this section were designed primarily to help readers understand the colonists' actions as motivated by their objection to the taxes.

The Intolerable Acts. This final section presents the information that the British responded to the Boston Tea Party with a punishing set of laws, called the Intolerable Acts. These acts included closing the port of Boston, disallowing self-government, and requiring the quartering of troops. Colonists in Boston alerted other colonies to the situation, which brought an influx of help and supplies and spread fear of similar retribution among the other colonies. The major problem with the original passage is that it does not explain the severity and significance of the punishments. The text simply says that the British *passed what the colonists called the Intolerable Acts* and that *intolerable* means "unbearable." The motivation for the acts is stated as being *to punish the people of Boston*, but the acts themselves are merely listed as follows:

> The port of Boston was closed. No self government was allowed in Massachusetts. British troops had to be housed and fed by the Massachusetts colonists.

In order to understand how the Intolerable Acts and the colonists' reaction to them were linked to the other events leading to the Revolution, a reader needs to understand the consequences of these Acts for the colonists. Thus, the major revisions involved explaining the severity and significance of each of the Acts. Consider just the discussion in the revised text of the Act that closed the port of Boston:

> These laws did many things that made life in Boston very difficult. For example, the British closed the port of Boston. That meant no ships could get in or out. Since most of Boston's supplies came in by ship, food and other important things soon became very hard to get.

The other colonies' reaction to the plight of Boston is also an important component of the major chain of events, but the original text is rather obtuse about why the other colonies were concerned. Consider the original and revised treatments of this issue:

> *Original:* People wondered if their colony would be the next to feel the anger of Great Britain.
>
> *Revised:* It frightened people in other colonies that Britain could act so harshly. People feared that their colony might be the next to feel the anger of Great Britain.

The revisions to this section, which focused on explaining the harshness of the Intolerable Acts and the colonists' reaction to them, were intended to prepare readers to understand the extent to which the conflict with Britain was intensifying.

Characteristics of all revisions. As noted earlier, the text revisions were designed to provide causal connections that were generally not offered in the original text. Thus, the revision was longer than the original; across all four passages, there were 583 words in the original text and 1,046 words in the revised text. However, students' comprehension was compared only on content that was common to both versions. Readability calculations using the Fry Readability Scale (Fry, 1975) yielded an average readability of 6.0 for the original text and 7.0 for the revised version.

Measures

To assess comprehension of these materials, we used both free recall and open-ended questions. Because young students tend to give limited recalls, particularly on relatively unfamiliar content, the questions that were developed for each passage were extensive. The same sets of questions were presented for the original and revised texts. The questions followed the sequence of the text and tapped knowledge of states, events, and relations between them. (The questions for the French and Indian War segment are shown in the Appendix.)

Procedure

The text materials were presented to each student in individual sessions with an examiner (one of the authors). The examiner followed a written script that included a brief introduction, instructions, recall prompts, and short-answer questions. Each student read the text silently in four sections (corresponding to the four topics discussed above), one section at a time. The student was asked to think of the sections as passages from the student's social studies textbook. After completing each section, the student was asked to tell in his or her own words what the section was all about and to respond to a series of open-ended questions. The recalls and answers to questions were recorded on audiotape and later transcribed for scoring.

The only difference in procedures between the two groups was that the fourth-grade students were presented with a very brief overview, lasting about 3 minutes, of some of the content that the fifth-grade students had studied over a 2-month period. This step was taken because the fifth-grade students had studied content that the textbook authors apparently intended as prerequisite for learning about the American Revolutionary period, and the fourth-grade students had not. Specifically, the examiner showed the fourth-grade students an outline map that showed the North American continent and Europe. Following a prepared script, the examiner pointed to the map as she told subjects that, a long time ago, people from England and France had come over to North America to explore the land. She indicated where the French had explored and settled, where the British had explored and settled, and the general location of the 13 British colonies.

Scoring

Scoring of the recalls. In order to compare students' recalls of the original and revised passages, we first analyzed the text into idea units to be used as a basis for scoring. Each of the four passages was divided into units based on a narrative analysis procedure developed by Omanson (1982) and used in previous work (Beck et al., 1982, 1984). Omanson's method involves analyzing clauses that portray an event or state into content units and the relations that connect these units.

In the present work, we adapted Omanson's procedure in order to use it with expository text, resulting in units that were often smaller than a clause. In the original procedure, a content unit is defined as portraying a single state or event. But because expository text is often more conceptually dense than narrative text, a single state or event may contain several chunks of information. For example, in Omanson's original procedure, the sentence *Britain would now rule Canada and other lands that had belonged to France* would be considered a single unit because it portrays a single state in terms of one main clause and a restrictive clause. In the present study, this sentence was divided into four units because it was determined that it contained four chunks of information:

1. Britain would now rule.
2. Canada would be under this rule.
3. Other lands would also be under this rule.
4. The land that would be ruled had once belonged to France.

The procedures for developing idea units for use as the scoring base involved first dividing the text into clausal units, then separating from the main clause any phrases that represented distinct states, events, locations, and qualifiers. Compound subjects and objects were separated, and separate units were designated for any complement that added content. The resulting units were generally smaller than clauses, but larger than propositions.

Because the elliptical nature of the original text required an inordinate number of inferences, we represented these in the scoring base as implied units. The criterion we used was to include as implied units only information that was deemed necessary for understanding. For example: for the text statement *In 1763, Britain and the colonies ended a 7-year war with the French and Indians*, we included the implied units *colonists with Britain* and *Indians with France* in our scoring base because a basic piece of information about a war is to know who is fighting whom, even though that information is not explicitly stated. In contrast, the information that the war began in 1756, which could be derived from the sentence, was not given status as an implied unit because it was not important for understanding the central events and states in the text.

To determine reliability, 30 percent of each text was independently divided into units by a second rater (another of the authors). An interrater reliability of .92 agreement was obtained. Disagreements were settled by mutual agreement. This procedure resulted in the identification of 145 idea units in the original text and 170 idea units in the revised text. For purposes of scoring, 124 units of common content were established between the two texts, and only the common content was scored. Each student was given credit for a unit if his or her recall contained the gist of that unit. Scoring was again done by one of the authors, and interrater reliability on 20 percent of the recalls scored independently by a second rater was .91 agreement. Disagreements were settled by a third rater.

Scoring of the question responses. In order to compare performance on the comprehension questions by students who read the original and students who read the revised text, we first developed a template of model answers to the questions. Of the 34 questions across the four segments, 28 were scored either 0 or 1. Half credit was possible for the remaining 6 questions. Because of the open-ended nature of the questions, reliability of the scoring was calculated. Like the recalls, the questions were scored by one of the authors; interrater reliability for 20 percent of the answers scored by a second rater was .94 agreement. Disagreements were settled by a third rater.

Quantitative results

In this section we present the results of the statistical analyses of comprehension performance on the original and revised text. The primary question posed by this study was whether the revised text produced better comprehension than did the original text. The data were analyzed to compare the number of common units recalled and the number of questions answered correctly by students who read the original and students who read the revised text.

Overall effect on comprehension

The data for recall of units common to both texts and the scores for answers to questions were examined in separate, mixed-design 2 × 4 analyses of variance (ANOVAs), with text type (original versus revised) as the between-subject factor and with passage segment (on the French and Indian War, "No taxation...," the Boston Tea Party, and the Intolerable Acts) as a within-subject factor.

Table 1 shows the mean percentage of content units recalled by students who read the original and revised texts. The table indicates that students who read the revised passages recalled more units from all four sections, and the total difference for all passages combined was significant, $F(1, 83) = 4.67, p < .05$.

The advantage in comprehension performance for students who read the revised text is even clearer in their answers to questions. Table 2 shows the mean percentage of questions answered correctly by both groups. Again the students who read the revised texts answered more questions correctly for all four passage segments than students who read the original, and the difference for all passages combined was significant, $F(1, 83) = 15.10, p < .01$.

Differential effects for four passage segments

Another question of interst in this study was whether there would be a difference in comprehension performance across the four passages. Specifically, we hypothesized that performance on the Boston Tea Party segment might be superior to performance on the other segments, both because of its more narrative style and because it was more likely that students would have encountered the information previously, in stories in trade books. Results showed that there were indeed significant main effects of passage segment on both percentage of content units recalled, $F(3, 249) = 48.72, p < .01$, and percentage of questions answered correctly, $F(3, 249) = 21.98, p < .01$. There was no significant effect of the interaction between text type and passage segment ($p > .05$). As shown in Tables 1 (for recall) and 2 (for questions), both the original and revised groups showed the highest comprehension performance on the Boston Tea Party segment and the lowest performance on the "No taxation" segment. It is not surprising that students had the most trouble with the "No taxation" text because it contains a very difficult concept, that of *representative government*, and there is evidence that students of this age have severely limited

Table 1 Means and standard deviations for percentage of content units recalled by students who read the original text and students who read the revised text

Passage segment	Total # of units	Original version *M*	Original version *SD*	Revised version *M*	Revised version *SD*
The French and Indian War	38	11.3	8.5	14.6	12.1
No taxation without representation	38	8.3	8.0	13.0	11.0
The Boston Tea Party	27	21.6	12.2	26.6	12.0
The Intolerable Acts	21	13.1	11.5	17.9	15.5
Total	124	13.6		18.0	

Table 2 Means and standard deviations for percentage of questions answered correctly by students who read the original text and students who read the revised text

Passage segment	Total # of questions	Original version *M*	Original version *SD*	Revised version *M*	Revised version *SD*
The French and Indian War	8	30.9	26.0	50.8	27.1
No taxation without representation	9	22.4	24.2	38.3	26.5
The Boston Tea Party	8	41.9	31.0	61.7	23.1
The Intolerable Acts	9	24.3	29.3	45.6	33.0
Total	34	29.9		49.1	

notions about this concept (McKeown & Beck, 1990).

The two dependent measures (recall and questions) reveal the same pattern of specific performance for the four passages. Given the limited amount of information young students provide in recall protocols, it is important that the question data support the recall findings.

Qualitative results

It is clear from the quantitative analyses that there were differences in the amount of text recalled and the number of questions correctly answered between the students who read the original and the students who read the revised text. Although these quantitative results reveal the presence of differences, they cannot show the nature of the differences. Thus, to investigate the nature of the differences between the representations students developed from reading the two different texts, qualitative methods were developed to analyze students' recall protocols and their answers to questions.

Analysis of prototypical recalls. The goal of the qualitative analysis of recalls was to portray any group differences in the nature of the information recalled from the two texts. It is difficult to compare the information recalled from two versions of a text because differences in wording between the texts are likely to result in differences in wording in the recalls. To overcome this problem, we developed prototypical recalls using language common to both texts. These prototypical recalls are models that reflect the recall of a typical student in each group. The models were developed from the set of units most commonly recalled by students who read the original and students who read the revised texts. This method of examining recall patterns has been used in previous studies (Beck et al., 1984; McKeown, Beck, Omanson, & Perfetti, 1983) and is similar to a method used by Spilich, Vesonder, Chiesi, and Voss (1979; see also Omanson, Beck, Voss, & McKeown, 1984).

The process of developing these prototypical recalls involved several steps. For each group, we first determined which of the units common to both texts were recalled by at least 15 percent of the students in that group. We chose 15 percent because this criterion resulted in the inclusion of enough units in the prototypical recalls to show differences between the two groups. (Although 15% was the minimum criterion for inclusion, some of the units were recalled by as many as 70% of the students.) The units that met the criterion were then assembled into paragraphs, adding only the wording necessary to form complete sentences. Because the purpose of these analyses was to allow comparison of the recall of the two groups, only the wording of the units as they had appeared in the revised text was used.

Analysis of question responses. The purpose of the qualitative analysis of question responses was to examine patterns of differences in students' understanding that might not have been revealed in the recalls. Because young students' recalls are typically rather sparse, the questions were intended to elicit students' ideas about important concepts from the text that they might not have included in their recalls—either because they did not remember at the moment or because they did not understand. Thus, the qualitative analysis of questions can provide a sense of the extent to which the students understood the main issues of the passages, and where their understanding went awry. To capture both understanding and misunderstanding, we examined the content of each question response and developed categories based on patterns that emerged.

In some cases, the categories were quite straightforward. For example, in the segment on the French and Indian War, responses to the question *Who was fighting against whom in the war?* were simply grouped according to the parties named. In other cases, however, we had to interpret the focus of the response and how it was related to the question. For example, for the question *What does it mean that the colonists were not members of Parliament?* we identified three categories of responses representing a range of understanding. The first category, which represents the fullest understanding of the target concept, included responses that discussed voting for government officials or having a voice in government (e.g., "They didn't get to vote for who they wanted to think up the laws"). The next category comprised responses that focused on the tax issue (e.g., "They weren't used to the taxes"). A third category included responses that merely mentioned the wording of *not being members*, but gave no interpretation to that phrase (e.g., "They didn't belong to it").

In the following sections, we present a comparison of the prototypical recalls for students who read the revised text and students who read the original text. A similar comparison is presented for the question responses. The analyses are presented by text segment because students were presented with one segment at a time, followed by the recall and questions for that segment. The question responses selected for discussion are those that portray a characterization of students' understanding of the main concepts and that capture the differences in understanding between the two groups.

The French and Indian War

Prototypical recalls. The prototypical recalls for the segment on the French and Indian War are shown in Table 3. Students who read either version typically recalled that Britain and France fought against each other, that Britain gained some control, and that the American Revolution was to follow. As shown in the table, students who read the revised text were likely to recall two important additional pieces of information: the motivation for the war (control of the land) and an outcome of the war (the colonists felt they would now be safe).

Table 3 Prototypical recall protocols for the French and Indian War text segments

Original text	Revised text
It was about the French and Indian War. In 1763, Britain and France had a war. Many Indians fought on the same side as France. Now Britain had control. *A dozen years* later the colonists would be fighting for freedom. This war would be called the War for Independence or the American Revolution.	It was about the French and Indian War. Britain and France had a war *to see who would get control of the land.* Many Indians fought on the same side as France. *The war ended* in 1763. *Britain won the war.* Now Britain had control. *The colonists felt safer and they were happy.* But then the colonists would be fighting for freedom. This later war would be called the War for Independence or the American Revolution.

Note. The italicized units in each prototypical recall are those units that were recalled only by students who read that version of the text.

Question responses. In general, the pattern of responses to questions about the French and Indian War segment showed that there were two main points of confusion: the identity of the agents who were involved in the war and the motivation for the war. In both cases, this confusion was more pronounced for the students who read the original text.

First, answers to the question *Who was fighting against whom?* revealed greater confusion about the combatants on the part of the students who read the original text, who showed no evidence of knowledge that the colonists were aligned with Britain. Specifically, only 23 percent of students who read the original text pitted the British against the French and Indians, and not one of these students mentioned the colonists as being on the side of the British. In contrast, 38 percent of the students who read the revised text correctly pitted the British against the French and Indians, and 11 percent of these students mentioned the colonists' alignment with Britain. The differences in understanding between students who read the two versions were more obvious in students' responses to the question *Who won the war?* Of the students who read the revised text, 80 percent correctly identified Britain as the winner; in contrast, only 45 percent of the students who read the original text were able to answer this question correctly.

The motivation for the war was a source of confusion for both groups, but the confusion was more serious for the readers of the original text. A correct response to *Why was the war fought?* (to gain control of the land) was given by 62 percent of students who read the revised text, but by only 35 percent of students who read the original version. The predominant response from readers of the original text was that the war was fought for independence (45%). At first it might seem that these students were confusing the French and Indian War with the colonists' upcoming fight for independence, which is foreshadowed in this section; however, only 22 percent of the students who gave this response identified the colonists as the party seeking independence. The majority (55%) of these students identified variously the Indians, British, French, or Canadians as the agents seeking independence. The confusion of students who read the original text over the motivation for the war also affected their answers to the question *What did they get by winning?* In response to this question, 69 percent of students who read the revised text correctly stated that the prize was land, but only 43 percent of the students who read the original text gave this response.

Overall, the qualitative analyses suggest that more students who read the revised text seemed-to complete this segment of the text having established a context for the events to come. That is, they had a clearer understanding that North America was controlled by Britain, that the colonists belonged to Britain, and that the colonists were currently satisfied with that situation.

Table 4 Prototypical recall protocols for the "No taxation..." text segments

Original text	Revised text
Britain wanted them to pay taxes. *Parliament passed tax laws* on glass, paint, and tea. The colonists thought these taxes were very unfair. They even destroyed tax collectors' homes. Britain decided to stop trying to collect the taxes *by 1770.*	Britain wanted them to pay taxes. *These taxes were put* on glass, paint, and tea. The colonists thought the taxes were very unfair. *The colonists were not allowed to vote. They felt that since they could not vote for the people who make the laws, they should not have to follow the laws. They would not pay taxes to that government. The colonists showed their anger by not buying anything that came from Britain.* They even destroyed tax collector's homes. Britain decided to stop trying to collect the taxes. *Only a few taxes were left.*

Note. The italicized units in each prototypical recall are those units that were recalled only by students who read that version of the text.

"No taxation without representation"

Prototypical recalls. Table 4 shows the prototypical recalls for this segment of the text. As shown in the table, students in both groups typically recalled that the British passed tax laws, that the colonists thought these laws were unfair, and that the colonists reacted by protesting the tax laws. The additional information recalled by students who read the revised text was related to the central theme of the passage: that the colonists were upset about the taxes because they had no voice in determining the tax laws.

Question responses. Students' understanding of the issue of Britain's tax laws and the colonists' reaction to them was captured in their responses to three questions, which center on the issue of the colonists' not having a say in Britain's government: *What does it mean that the colonists were not members of Parliament? What does "No taxation without representation" mean?* and *Why were the colonists upset about the taxes?* In responses to the first two of these questions, students who read the revised text showed a striking advantage in understanding the issues underlying the colonists' discontent.

In response to the question regarding the colonists' lack of membership in Parliament, 38 percent of the students who read the revised text responded that this meant that the colonists had no representation (e.g., "They didn't have anybody to vote for and the British did"), but only 8 percent of the students who read the original text gave this response. The greatest proportion of students in the original group (33%) indicated that membership in Parliament had something to do with the taxes, but did not relate the issue to the concept of representation (e.g., "Since they weren't members they had to pay taxes").

In response to the direct question regarding the meaning of "No taxation without representation," more than three times as many students in the revised group (51%) as in the original group (15%) included in their response the point that the colonists had no voice in government. It is not surprising that so many more students in the revised text condition showed an understanding of representation because the revised text explains this concept, whereas the original text leaves it to be inferred from very obtuse text statements.

Students who read the revised text were thus much more able to grasp the issue that caused the colonists' anger and their actions of protest. However, when specifically asked why the colonists were upset about the taxes, they still tended to cite only financial concerns. The most common response both from students who read the original (35%) and from students who read the revised text (44%) was that the colonists' distress over taxes was simply a matter of

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Table 5 Prototypical recall protocols for the Boston Tea Party text segments

Original text	Revised text
It was about the Boston Tea Party. *The British kept a tax on tea.* The colonists' feelings about Britain's taxes had not changed. The colonists refused to buy any tea. The British greatly lowered its price. The British thought that surely the colonists would buy tea. So they sent boatloads of tea to the colonies. The colonists were as angry as ever. The colonists burned some of the tea. They left some to rot. The Sons of Liberty late one night threw more than 300 chests of tea into the water. The colonists called this the Boston Tea Party.	It was about the Boston Tea Party. The colonists' feeling about Britain's taxes had not changed. The colonists refused to buy any tea. *Britain hadn't been able to sell their tea.* They greatly lowered its price. *Now the price of tea was less than it had ever been, but it still included the tax.* The British thought that surely the colonists would buy tea. So they sent boatloads of tea to the colonies. The colonists were as angry as ever. The colonists burned some of the tea. They left some to rot. The Sons of Liberty *snuck into Boston Harbor* late one night, and threw more than 300 chests of tea into the water. The colonists called this the Boston Tea Party.

Note. The italicized units in each prototypical recall are those units that were recalled only by students who read that version of the text.

money (e.g., "cause they didn't think that they should have to pay extra money to buy the stuff"). Only 16 percent of the revised group and 5 percent of the original group stated that the colonists were upset because they were not represented in the decision leading to the taxes.

One hypothesis for this seeming inconsistency is that, even though information about the principle was available to students in the revised group, they (like the students who read the original text) tended to base their responses on a more familiar notion—that taxes mean paying money, and no one favors that. The concept of representation is much more complex and novel for these students, so they responded from a more easily accessible notion.

The Boston Tea Party

Prototypical recalls. Table 5 shows the prototypical recalls for the Boston Tea Party segment. As shown in the table, students who read either text tended to recall that the colonists still felt the same about the taxes, that they refused to buy tea, that Britain lowered the price of the tea, and that the colonists took actions to destroy the tea. No student in either group mentioned during free recall that Britain was trying to assert its authority by maintaining the tea tax, or that the colonists' actions regarding the tea were in protest against the tax laws. Although the students who read the revised text did tend to recall that there was still a tax on tea even after the price was lowered, the recall protocols, in general, do not show major differences in the quality of information recalled.

Question responses. Analyses of the question responses, however, did reveal some differences in the understanding students gained from the two texts. These differences were particularly evident in responses to two questions regarding colonial protests. The first asked why the colonists carried out actions such as burning the tea and leaving it to rot even after the price of tea was lowered. Twice as many students who read the revised text (80%) as students who read the original text (40%) understood that these actions were done in protest (e.g., "They got real angry...and one night they threw it over the boat because they still had taxes on them."). Responses from the students in the original group that did not mention the concept of protest (60%) showed a variety of ideas about the colonists' actions. These responses ranged from saying that the colonists were motivated solely by the price of tea (23%) to saying that the colonists did in fact buy the lower-priced tea (10%).

The second question that tapped an understanding of the colonists' motivations was the question of why the colonists threw the tea in

Table 6 Prototypical recall protocols for the Intolerable Acts text segments

Original text	Revised text
It was about the Intolerable Acts. The British were very angry about the "Tea Party" and decided to punish the people of Boston. The port of Boston was closed. And, the British made the colonists provide housing and food for their soldiers. Colonial leaders in Boston quickly sent letters to the people in the other colonies. *People feared that their colony might be the next to feel the anger of Great Britain.*	The British were very angry about the "Tea Party" and decided to punish the people of Boston. *When something is intolerable it means you just can't stand it. The British* closed the port of Boston. *That meant no ships could get in or out. Food and other important things soon became very hard to get. The colonists used to be able to make some decisions on their own, but now Britain took those rights away.* And, the British made the colonists provide housing and food for their soldiers. Colonial leaders in Boston quickly sent letters to the people in the other colonies. *They sent help and supplies.*

Note. The italicized units in each prototypical recall are those units that were recalled only by students who read that version of the text.

the water. Considerably more students who read the revised text (66%) than students who read the original text (38%) understood that the colonists were trying to "get back at Britain" by staging the Boston Tea Party. Typical correct responses were "They weren't going to buy it cause it still had tax on it and they wanted to get Britain mad," and "...to show the king that they didn't want to be bossed around."

Another difference between the two groups was evidenced in their responses to questions regarding the agents of the action of throwing the tea into Boston Harbor. Both texts label the perpetrators of the Boston Tea Party as the Sons of Liberty. Neither text directly states in this segment that the Sons of Liberty were colonists, but this fact must be inferred if readers are to understand the implications of the events. When asked who the Sons of Liberty were, 60 percent of the students who read the revised text responded that they were colonists, whereas only 15 percent of the students who read the original text knew their identity. Similarly, when asked who was responsible for the Boston Tea Party, considerably more students who read the revised text (61%) than students who read the original text (40%) were able to respond that it was the colonists.

In sum, the students who read the revised text seemed to have a better understanding of the motivations underlying the colonists' actions and a more secure notion of the colonists' role in the activities portrayed in this segment of the text.

The Intolerable Acts

Prototypical recalls. Table 6 shows the prototypical recalls for the final segment of the text. As shown in the table, students in both groups typically recalled that Britain was angry about the Boston Tea Party and decided to punish the people of Boston. They typically named two of these punishments, the closing of the port of Boston and the quartering of troops. In addition, students who read the revised text tended to recall the third punishment, that Britain took away their right to self-government. Students who read the revised text also recalled the implications for the colonists of the closing of the port of Boston.

The two groups also differed in their recall about the response of the other colonists. Those students who read the original text tended to recall that the other colonists feared retribution, whereas the students who read the revised text tended to recall that the other colonists sent help and supplies to the Bostonians.

Question responses. Responses to the questions about the Intolerable Acts suggest that the students who read the revised text had access to some of the elements that were necessary for building an understanding that these acts created a situation of severe hardship in the Massachusetts colony. In addition, the revised group understood that the colonists' reactions to the laws promoted colonial unity, which fostered a Revolutionary spirit.

One question that revealed a difference between the groups tapped students' understanding of the reason the colonists labeled Britain's new laws *intolerable*—which was to indicate their shocked reaction to the harsh treatment of Boston. Nearly half (47%) of the students who read the revised text understood that *intolerable* referred to the British government's punishment of Boston. In contrast, the most common response from students who read the original text, given by nearly a third (32.5%) of the students, was that *intolerable* applied to the colonists' action of wasting tea.

Another important element in understanding the situation in Boston is knowing that the British, as part of their punishment of the colonists, closed the port, resulting in serious shortages of food and supplies. Three questions focused on the closing of the port of Boston: *What happened to the port of Boston? What happened when the port of Boston was closed?* and *Why did they close the port?* Although most students in both groups replied to the first question that the port had been closed (revised, 78%; original, 60%), not all students knew who had closed it. Of those students who responded that the port had been closed, more students who read the revised text (77%) than students who read the original text (54%) reported correctly that it was the British who closed it, rather than the colonists themselves.

There was a marked difference between the two groups in response to the question *What happened when the port was closed?* Of the students who read the revised text, 44 percent responded that the closing of the port resulted in hardship for Boston (e.g., "They were unable to get food and supplies"). The best that students who read the original text were able to do, in contrast, was to respond that no ships could come in or out of the harbor; this was the most common response (25%). No students in the original group gave any evidence of an understanding that this was a hardship for Boston. Not surprisingly, when asked why the port was closed, more students who read the revised text (55%) than students who read the original (23%) realized that the port was closed in order to punish Boston.

Finally, a more abstract issue tapped by the questions for this segment was the provision of the Intolerable Acts that banned colonial self-government. Because the principle of self-government was so significant to the colonists, understanding Britain's ban reinforces an understanding of the severity of the hardships imposed on Massachusetts. When asked about the meaning of the phrase *No self-government was allowed*, more students who read the revised text than the original text responded that it meant that the British took away the colonists' right to self-rule. Even so, only 27 percent of students who read the revised text and 15 percent of students who read the original text gave this response. Thus, it seems that an understanding of this issue was beyond the grasp of the majority of students in both groups.

It appears that, by the time they had completed this final passage, most students who read the revised text had developed an understanding of the situation in Boston and of the troubled relationship between Britain and the colonies that would serve as an appropriate base for understanding subsequent events. In contrast, the representation that most students seem to have constructed from reading the original textbook presentation is unlikely to prepare them for an understanding of the outbreak of a revolution.

Discussion

The poor quality of texts is a common complaint. Thus, it may not seem surprising that students have difficulty understanding them or that better texts can be created. Our intention in this research was to go beyond such a straightforward demonstration in order to examine the *quality* of the improvements in comprehension fostered by effective revisions, and to describe the nature of those revisions. The effects of the revisions we made demonstrate that a text-processing approach is effective for creating comprehensible text. The proportion of recall and the proportion of questions correctly answered were reliably higher for the students who read the revised version than for the students who read the original text.

The improvement in comprehension for readers of the revised text was not only a matter of remembering more of the text. The difference between the two groups in the nature of the content recalled and information put forth in answers to questions most typically represented exactly the concepts needed to explain the actions of the text and to move the chain of events forward. For example, when recalling the French and Indian War segment, the readers of the original text tended to omit mention of the colonists and of who was fighting whom in the war. Similarly, for the section on "No taxation without representation," the students who read the revised text were more likely than the other students to understand that the colonists' distress over taxes arose from their desire for representative government. Students who read the original text on the Boston Tea Party were less likely than those who read the revision to make the critical connection between the tea action and the tax situation. Finally, readers of the original text on the Intolerable Acts did not seem to grasp the power of the events, as evidenced by their confusion over what had been labeled *intolerable* and who closed the port of Boston.

There are two issues of note regarding the kinds of information that both groups of students took from the text. One is that the representations of the text developed by students who read the revised version demonstrate the success of our approach to revisions. Our overall goal was to present the events and ideas in a causal/explanatory style so that students would understand not only the events themselves but also why the events occurred and how events and ideas were related to one another. In most cases, the advantage in recall and question answering of students who read the revised text comprised this causal-connective information.

The other issue is the extent of confusion exhibited by the readers of the original text. Although we had predicted many of the problems students had in understanding this text, such as in identifying the combatants in the French and Indian War, comprehending the concept of representative government, and realizing the severity of the Intolerable Acts, the students' lack of understanding of some of the more basic information was a bit surprising. In particular, confusion about the agents who were involved in the actions was prevalent throughout the text. In reading the French and Indian War text, the students not only confused the agents, but they rarely included the colonists in their recalls of the passage. In reading the "No taxation..." passage, nearly half of the students failed to realize that it was the colonists who were asked to pay taxes. In reading the Boston Tea Party text, many students were confused about who launched the Tea Party. Clearly, if confusion is pervasive at this level of information, little is going to be learned from the text. In fact, the representations that students develop may be inaccurate conceptions of the events portrayed.

Although the revisions were successful in improving students' comprehension, they had their limitations. The study demonstrated increases in the quantity and quality of information recalled, but there was still room for improvement. One area of weakness was in the explanation of complex issues, such as the concept of representative government, and the British act barring the colonists' rights to self-government. Although there were more students who evidenced understanding of these issues among the students who read the revised text than among the students who read the original text, the students who showed improved comprehension still did not constitute a majority of the revised text's readers.

The limitations of a carefully crafted revision may at first seem rather sobering. But a message that one should discern from these limitations is that learning complex content is difficult, and simply explaining the issues better in the text is not likely to accomplish the whole task. It is important to realize that even a coherent, well-designed text is unlikely to communicate to a young learner all the information that a mature reader could glean from it. When learning complex content, young students typically need several reiterations of ideas as well as opportunities for discussion in order to clarify and elaborate their initial conceptions.

Our approach to revising texts was developed as a way to apply findings from recent cognitive theory and research about features that aid or impede reader/text interactions to the creation of more comprehensible texts. However, we did not simply search for specific features that have been shown to be problematic, and execute prescribed changes at each occurrence of those features. Such an algorithmic application of findings about reader/text interactions is not possible. For example, it is impossible to specify outside of a specific context how much distance between referents can be tolerated before comprehension breaks down, how much needs to be included in a text to avoid knowledge gaps, or what makes for clear relationships between ideas.

Instead, we applied cognitive findings to the creation of more comprehensible texts by attempting to simulate the reader's mental processes while moving through a text. We generated hypotheses about the reader's text representation as it developed from the content presented, the prior knowledge required to understand the text at each point, and specific features of the text presentation. One must consider the interplay of all these factors because a text's content is inseparable from the effort it takes to make it comprehensible; the effectiveness of various features of texts is different for different content and different readers. For instance, although one of the tenets of coherence in discourse is explicitness of the ideas presented, creating comprehensible text should not be equated with a global goal of making all concepts explicit. Decisions about which concepts to make explicit should be based on the role of each concept in a specific text situation and the goals of the text.

In this study we also attempted to expose the reasoning underlying text revisions by describing the operations and decisions involved in identifying problems and creating solutions. We believe this method represents an advance in the way revisions are described and moves beyond Duffy et al.'s (1989) suggestion of creating a library of text problems and their solutions. Our approach has added, in effect, an "executive component" that describes the thinking that relates the problem to the solution. We described how text problems were identified and why they might inhibit comprehension, as well as how we developed potential solutions and why the solutions might work. This approach addresses the concern that many researchers have expressed about the difficulty of describing and communicating what goes into revisions. The approach described here might prove helpful to anyone responsible for creating or revising text.

Communicating how to do something is not a problem in a domain that allows the straightforward application of rules and procedures. But because of the nature of language, and the interactive and cumulative nature of the task of constructing meaning from extended discourse, creating comprehensible text is a very complex task, and its complexity precludes devising a set of formulaic procedures. We are therefore left with weak heuristics—the same heuristics that others have applied to text revision with some success, but which are not generative. What we have attempted to do is to anchor these heuristics by drawing connections between general principles—grounded in research and theory about the reading process—and specific text problems, and by describing the operations and decisions involved in getting from one to the other. In other words, we have provided models of text—the original and revised versions—along with the explanations that connect them. It is our notion that providing these may be generative because models accompanied by explanations can serve as mechanisms for transferring knowledge to new instances.

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Footnotes

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APPENDIX

Text and comprehension questions for the French and Indian War

Original text:

The French and Indian War

In 1763 Britain and the colonies ended a 7-year war with the French and Indians. As a result of this war France was driven out of North America. Britain would now rule Canada and other lands that had belonged to France. This brought peace to the American colonies. The colonists no longer had to fear attacks from Canada. The Americans were happy to be a part of Britain in 1763. Yet a dozen years later, these same people would be fighting the British for independence, or freedom from Great Britain's rule. This war was called the War for Independence, or the American Revolution. A revolution changes one type of government or way of thinking and replaces it with another.

Revised text:

The French and Indian War

About 250 years ago, Britain and France both claimed to own some of the same land, here, in North America. This land was just west of where the 13 colonies were. In 1756, Britain and France went to war to see who would get control of this land. Because the 13 American colonies belonged to Britain, the colonists fought on the same side as Britain. Many Indians fought on the same side as France. Because we were fighting against the French and Indians, the war has come to be known as the French and Indian War.

.The war ended in 1763. Britain won the war. Now Britain had control of North America, including Canada. The French had to leave North America.

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The colonists were very glad that Britain had won. They now felt safer in their homes. Before the war, Indians had often attacked colonists who lived near the borders. Now Britain owned these lands where the Indians lived. The colonists were sure that Britain would protect them.

The colonists were happy to be a part of Britain, but that was about to change. They began to decide that they would rather have their own country, independent from Britain. So a dozen years later, the colonists would be fighting the British for freedom from Great Britain's rule. This later war would be called the War for Independence, or the American Revolution.

Open-ended questions:

1. Who was fighting against whom in the war?
2. Where did the war take place?
3. Why was the war fought?
4. Who won?
5. What did they get by winning?
6. Who had the land before?
7. Right after the French and Indian War how were the colonists and the British getting along?
8. At the end of the part you just read, it said something about what was going to happen later on. Can you tell me anything about that?

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SENSE MAKING AND THE SOLUTION OF DIVISION PROBLEMS INVOLVING REMAINDERS: AN EXAMINATION OF MIDDLE SCHOOL STUDENTS' SOLUTION PROCESSES AND THEIR INTERPRETATIONS OF SOLUTIONS

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In this study, about 200 middle school students solved an augmented-quotient division-with-remainders problem, and their solution processes and interpretations were examined. Based on earlier research, semantic-processing models were proposed to explain students' success or failure in solving division-with-remainder story problems on the basis of the presence or absence of an adequate interpretation provided by the solver after obtaining a numerical solution. In this study, students' solutions and their attempts and failures to "make sense" of their answers were analyzed for evidence that supported or refuted the hypothesized semantic-processing models. The results confirmed that the models provide a solid explanation of students' failure to solve division-with-remainder problems in school settings. More generally, the results indicated that student performance was adversely affected by their dissociation of sense making from the solution of school mathematics problems and their difficulty in providing written accounts of their mathematical thinking and reasoning.

In recent years, research interest in children's ability and tendency to "make sense" of the mathematics they learn has manifested itself in many different ways, such as an interest in the connections between procedural and conceptual knowledge (e.g., Hiebert, 1986), in the meanings children impose on the mathematical symbols and procedures they learn (e.g., Resnick, 1988), and in the ways in which children connect or fail to connect school learning to everyday experience (e.g., Saxe, 1991). Interest in children's meaningful interpretations of school mathematics, however, is not a new phenomenon; it figured prominently in the writings of Dewey (1910, 1933), Brownell (1935, 1947) and others earlier in this century.

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Subject-Area Learning

Solution Processes and Their Interpretations

This paper reports the latest in a series of studies investigating children's "sense making" as it relates to the interpretation of a numerical answer obtained while solving division story problems involving remainders. The failure of American students to succeed in solving problems involving whole-number division with remainders has been documented through the National Assessment of Educational Progress (NAEP) and several state assessments. Only 24% of a national sample of 13-year-olds was able to solve correctly the following problem, which appeared on the Mathematics portion of the Third National Assessment of Educational Progress (NAEP, 1983): "An army bus holds 36 soldiers. If 1,128 soldiers are being bused to their training site, how many buses are needed?" A similar division problem appeared on the 1983 version of the California Assessment Program (CAP) Mathematics Test for Grade 6 and was answered correctly by only about 35% of the sixth-graders in California (Silver, 1986). In both assessments, students commonly erred by giving non-whole-number answers.

To better understand the basis for the observed difficulty that students have in solving division problems involving remainders, several investigations have been conducted with students in grades 6, 7, and 8 (Silver, 1986, 1988; Silver, Mukhopadhyay, & Gabriele, 1992). The findings of these investigations have suggested that students' failure to solve division problems with remainders can be attributed, at least in part, to their failure to relate computational results to the situation described in the problem. Because the same symbolic division expression can represent different problem situations, the determination of the correct solution to a problem depends on aspects of the situational context and the quantities involved in the problem. Unlike the case for most other story problems encountered by students in elementary school, sense making is not an optional activity in solving these problems, because correct computation alone cannot ensure a successful solution.

Recent studies (Silver, 1988; Silver et al., 1992) have examined students' performance on division problem types including augmented-quotient problems, remainder-only problems, and quotient-only problems. These studies examined the effects on students' performance of their solving several division problems that required the same computation and similar referential mappings. The results indicated that students' performance on each type of problem was enhanced by having them also solve related division problems. In general, the results were consistent with the explanation that the enhanced performance was due to the students' increased sensitivity and attention to the relevant semantic and referential mappings involved in the target problem solution. In particular, experience with the related problems may have drawn attention to the need for mapping into either the story text representation or the story situation representation after obtaining a solution to the augmented-quotient problem through use of a mathematical model.

Taken together, these results and the assessment findings suggested that the students' failure to solve the division story problems was due, at least in part, to an incomplete mapping among relevant referential systems. In particular, it appeared that students might map successfully from the problem text to a mathematical model (in this case, a division computation to be performed) and compute an answer within the domain of the mathematics model, but fail to return to the problem story text or to the story situation referent in order to determine the best answer to the question. Figure 1 presents a schematic representation of a hypothesized version of a student's unsuccessful solution (US) attempt.

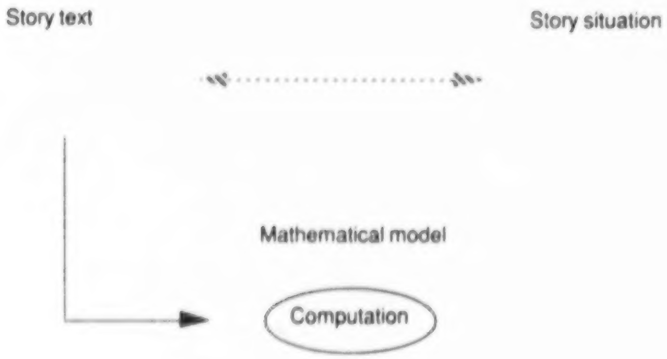

Figure 1. Schematic representation of hypothesized unsuccessful solution.

From this hypothesized model, it is possible to suggest that a student's successful solution attempt would be represented as follows: The solver maps from the story (natural language) text representation of the problems into a mathematical model representation, then performs the required computation within the referential system of mathematics, expressing the resulting answer with an appropriate mathematical representation. The solver then maps the computational result back either to the story text representation or to the implied story situation (in the "real world") representation in order to decide how to treat the quotient and remainder. Through such a process, the successful solver would finally obtain suitable mathematical and natural language representations of the solution that have accompanying interpretations and validity within the referential systems of real-world situations and the knowledge domain of mathematics. Figure 2 provides a schematic representation of the mappings involved in this idealized successful solution (SS).

Until recently, evidence for these hypothesized solution models was available only indirectly from an examination of students' performances on multiple-choice test items. Direct confirmation of these models of successful and unsuccessful solutions was obtained in an interview study (Smith & Silver, 1991) in which the problem-solving and interpretation performance of eight middle school students was examined in an interview setting where the students solved an augmented-quotient division-with-remainders problem.

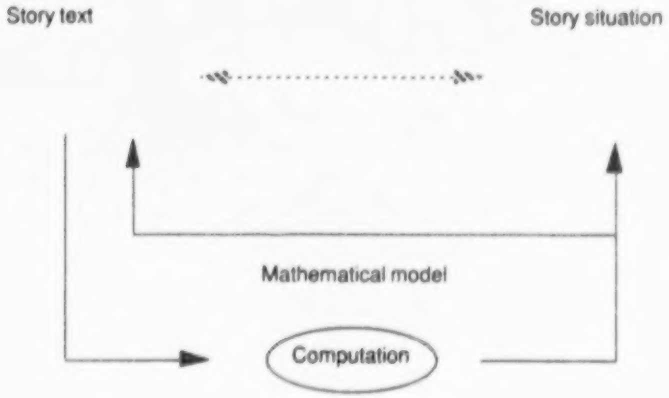

Figure 2. Schematic representation of an idealized successful solution.

In addition to confirming the semantic-processing models, the interview protocols reported by Smith and Silver (1991) also revealed some interesting facets of students' sense making with respect to the division problem task. In addition to the finding that the students who correctly solved the problem included a sense-making step in their solution, the interviews revealed that some students, who would have answered incorrectly if the tasks were presented in a multiple-choice format, were able to offer interesting interpretations of their numerical answers. For example, one student spoke of "squishing in" the extra students, and others suggested ordering minivans rather than a full bus for the extra students. This kind of situation-based thinking and reasoning remained invisible both in the multiple-choice response format used in the prior research and the kind of summary information available from the free-response solutions on the NAEP (1983) task.

The major purpose of the study presented here was to investigate, on a larger scale than the Smith and Silver (1991) research, the solution processes and interpretations of students solving an augmented-quotient division-with-remainders problem. Because the research prior to the Smith and Silver study had relied on multiple-choice items, little information was available regarding the processes used by students as they solve such problems. In the present study, the focus was on analyzing students' responses both to see if they provided evidence supporting or refuting the hypothesized referential models and to determine the extent and nature of students' attempts at sense making in the context of solving a particular type of mathematics problem. To facilitate the collection of more easily analyzable responses from a relatively large number of students, a free-response pencil-and-paper task was used. Unlike the multiple-choice tasks used in the prior research, this task format provides fairly direct access to students' thinking and reasoning about a problem, if they are willing and able to express their thoughts in writing. Finally, given the evidence of situation-based reasoning found in the Smith and Silver study, it was hypothesized that the number of "leftovers" might influence students' situation-based interpretations and final solutions. Thus, remainder size was chosen as a variable of interest.

METHOD

Sample

The sample consisted of 195 sixth, seventh, and eighth graders from a large urban middle school with a population approximately 40% Caucasian and 60% African-American of all ability levels. The students were members of mathematics classes taught by teachers who volunteered their classes.

Task

The following task was administered to each student in the sample:

> The Clearview Little League is going to a Pirates game. There are 540 (or 532 or 554) people, including players, coaches, and parents. They will travel by bus, and each bus holds 40 people. How many buses will they need to get to the game?

Three versions of this problem were used so that student responses would be obtained for division problems with remainder sizes equal to one-half (540 people), less than one-half (532 people) and greater than one-half (554 people).

Administration and Procedures

The task was administered to three classes at each grade level as a 15–20-minute activity during a regular class session. At each grade level, each version of the problem was administered to one class. The instructions accompanying the task directed students to show their work, to place their answer in an answer space provided, and to explain their answer in writing.

RESULTS

Since neither grade level nor ethnic differences were of particular interest in this study, results are reported for the aggregated sample. Students' responses were examined with respect to four distinct aspects: (a) solution process, (b) execution of procedures, (c) numerical answer, and (d) interpretations. Each aspect was examined independently, and then an additional analysis was conducted in which various combinations of these aspects were examined.

Solution Processes

The solution process was defined as the set of procedures used by the student to obtain a numerical solution. Although there were many solution processes that could have been used to solve the problem, such as drawing pictures or forming sets, all of the students' written responses indicated use of an algorithm. The majority of students used the long division algorithm (70%), but a significant minority (20%) of students used other algorithmic procedures, such as repeated addition. Table 1 exhibits the most frequently used algorithmic procedures and the percentage of students using each procedure. An algorithm was considered appropriate if it could potentially lead to a correct solution without requiring additional procedures not in evidence in a student's response.

Table 1
Distribution of Solution Procedures

Procedure	Percent of student usage	
Appropriate procedures		
Long division	73%	
Repeated multiples	7%	
Repeated addition	5%	
Repeated subtraction	1%	
More than one correct procedure	5%	
Total		91%
Inappropriate procedures		
Addition (dividend + divisor)	1%	
Subtraction (dividend − divisor)	1%	
Multiplication (dividend × divisor)	2%	
More than one incorrect procedure	3%	
Total		7%
No work provided		2%

Execution of Procedures

The execution of procedures referred to the actions taken by the student in carrying out the solution process. Since all students in the sample used an algorithmic procedure, examination of the execution of procedures was reduced to examining the correctness of the steps in the algorithm. A student's execution of procedures was judged to be correct if and only if each arithmetic operation in the procedure was executed without error. The work of those students who used an inappropriate algorithm to solve the problem was eliminated from examination. Table 2 shows the percentage of students who were successful or unsuccessful in executing the steps of the procedures for each of the appropriate algorithms used by the students. Overall, about 61% of the students were able to perform their calculations flawlessly. The long division algorithm, though the procedure most often used by the students, was the most difficult for them to perform correctly.

Table 2
Percentage of Students with Correct Execution by Procedure

	n	Percent with correct execution
Appropriate procedures		
Long division	142	58%
Repeated multiples	13	77%
Repeated addition	10	80%
Repeated subtraction	3	67%
More than one correct procedure	9	67%

Numerical Answer

The number written by a student in the space provided for the answer to the initial problem "How many buses are needed?" was considered to be the student's numerical answer. Table 3 indicates the numerical answers given by the students and the percentage of the sample giving each answer.

Table 3
Distribution of Students' Numerical Answers

Numerical answer	Number of students	Percent of students
14	84	43%
13	15	8%
13 and fractional remainder	11	6%
13 and whole number remainder	5	2%
13 and decimal remainder	2	1%
13 and other remainder representation	2	1%
Whole number remainder only	5	2%
Other answers	62	32%
No numerical answer	9	5%
Total	195	100%

Most of the response categories are self-explanatory, including those involving the mathematical expression of the remainder as a whole number, fraction, or decimal. These categories accounted for about 10% of the total number of student responses.

A few response categories deserve special attention. For example, the two responses in the category "13 and other remainder representation" appeared to involve a combination of mathematical and situation-based knowledge (e.g., "13 and 1 cab" and "13 and a minivan"). In the category "Other answers," nearly one-third of the responses involved a numerical answer greater than 100—responses that resulted from students' incorrect execution of the decimal division algorithm.

Interpretations

Interpretations were the explanations of solutions written by students in the space provided for that purpose.

Coding. Interpretations were coded as "appropriate," "inappropriate," or "no interpretation." An interpretation was coded as appropriate if, in the written explanation, the student said that a whole number of buses was needed because a fraction of a bus did not make sense or that there were some people who would not be able to go if an extra bus was not provided. In addition, if a student suggested that the fractional remainder represented a minivan or gave some other reasonable meaning to the numerical answer, the explanation was coded as an appropriate interpretation. An interpretation was coded as inappropriate if a student explained the numerical answer by applying rounding or estimating rules, offered an incomplete or incorrect explanation, or otherwise gave evidence of confusion. A response was coded as involving no interpretation if it was simply an explanation of the procedures used to find the solution, if it was a statement commenting generally or vaguely on the problem or the answer, or if no written explanation was provided.

To ensure interrater reliability a sample of approximately one-third of the responses was coded independently by each of two raters. An acceptably high degree of agreement between raters was obtained (Kappa = .94).

Appropriate interpretations. About one-third of the students gave responses that were classified as appropriate interpretations. Examples of interpretations considered appropriate include one student who wrote, "You'll need 13 and a third buses. Since buses don't come in thirds, you get a whole other bus," and another student who wrote, "14 to hold everyone, and you would have empty seats for more people who decided to come."

Some appropriate explanations were provided for final answers other than 14. For example, one student who gave a final answer of 13 1/2, wrote: "520 people are riding a big bus, and you'd have to get a van for the other 20 [people]." Some students who provided final answers of 13 1/2 gave interpretations such as, "You need 13 buses and 1 van [cab or minibus]."

Inappropriate interpretations. Only 9% of the sample gave explanations that were classified as inappropriate. Examples of inappropriate explanations include one student who wrote: "[The answer is] 14 buses because there's leftover people and if you add a zero you will get 130 buses so you sort of had to estimate. Are we allowed to add zeros?" Another student, after attempting decimal division, reported: "[The answer is] 14. I got 13.065 but just looking at the number I wouldn't get that so I took the first 2 digits and added 1 because about 5 [students] would be left."

No interpretation. More than half of the responses for the entire sample were classified in this category. In addition to papers containing no written explanation, this category also included those papers containing only general comments on the problem or the answer, such as the student who obtained an answer of 133 and wrote, "I was agassed [sic] at how many times it [the divisor] went in."

More than one-half (54%) of the sixth-grade responses were classified as procedural explanations (e.g., "I divided 40 into 540 and there is a remainder of 20, then I reduced 20/40 to 10/20, and then I took off the zero and came up with 13 1/2"), and none of these sixth-grade students also provided an interpretation of their numerical answer. In contrast, although more than 40% of the seventh- and eighth-grade students also gave detailed descriptions of their mathematical procedures, many also provided an interpretation for their solution, and their interpretations were often classified in the other categories. In general, students' procedural explanations related to the execution of the steps of an algorithm or a particular representational form of the numerical answer.

Response Patterns

Thus far, each aspect of a student's response has been treated independently. Determination of evidence that supports or refutes the hypothesized semantic-processing models requires examining the interplay among the various response components. Approximately 78% of the responses provided direct evidence to support at least one of the hypothesized SS and US models, about 14% of the responses provided what may appear to be counter-evidence for one of the models, and the remaining 8% were judged to be neutral or impossible to classify with respect to the models.

Direct supporting evidence for the hypothesized SS model was provided by approximately 32% of the responses. In particular, about 26% of the students gave a numerical answer of 14 and provided an appropriate interpretation, nearly 3% provided an answer other than 14 but also gave an appropriate interpretation, and about 3% had flaws in the execution of their solution procedure but were able to obtain an answer of 14 and give an appropriate interpretation.

Evidence directly supporting the hypothesized US model was provided by approximately 46% of the responses. In particular, about 22% of the students correctly executed an appropriate solution procedure but provided no interpretation for their incorrect numerical answer; nearly 24% of the students incorrectly executed an appropriate procedure, gave a numerical answer other than 14, and provided no interpretation.

Possible counter-evidence for the hypothesized SS model was supplied by about 8% of the students, who were able to provide the correct numerical answer of 14 without providing any accompanying interpretation; approximately 2%, who gave an inappropriate interpretation for the answer of 14; and about 4%, who gave an inappropriate interpretation for an answer other than 14. Further examination of many of the cases providing the apparent counter-evidence revealed some interesting tendencies in these responses. For example, a few of the students who obtained the numerical answer 14 but provided no interpretation used a repeated addition procedure—an algorithm that is generally not associated with direct instruction in division story problems. In the case of the students who gave an inappropriate interpretation for the answer 14, they gave explanations involving rounding and estimation—topics also taught in the school mathematics curriculum.

Remainder Size

The written responses of the students offered no direct evidence of students being influenced by the size of the remainder in interpreting their solutions or arriving at their final numerical answer. There was, however, evidence that remainder size interacted somewhat with success in executing procedures and in students' tendency to interpret numerical answers. Students who had the problem version with remainder size equal to one-half more often executed their computational procedures correctly than their counterparts who had other versions of the problem. Moreover, students' responses for the problem form in which the remainder was one-half were also somewhat more likely to reveal some attempt to interpret the numerical answer.

DISCUSSION

The major goals of this study were the examination of solution processes and interpretations provided by students when solving an augmented-quotient division-with-remainders problem, with particular focus both on analyzing students' responses for evidence that supported or refuted the hypothesized referential mapping models proposed in earlier research (Silver et al., 1992) and on examining the sense making evident in the students' responses. A more minor goal was to determine the extent to which remainder size influenced students' solutions or interpretations.

Relation to Hypothesized Models

The responses provided by students in this study generally supported the hypothesized SS and US models. Over 70% of the students used the long division algorithm to solve the problem (a finding consistent with the earlier NAEP report), and an additional 20% used other appropriate procedures. Over 60% of these students were able to execute their computation correctly, yet only about 45% of the subjects responded with the augmented quotient (14) as their numerical answer or were able to give an appropriate interpretation for some answer other than 14. Overall, students' responses provided considerable evidence that computational requirements were not the major barrier to obtaining a correct solution but rather that unsuccessful solutions were more often due to students' failure to engage in interpreting their computational results.

Successful solution model. Direct evidence to support the SS model is provided by the responses of nearly 70% of the students who gave the augmented quotient (14) as their numerical answer and also provided appropriate interpretations for their answer. Moreover, the few students who gave answers other than 14 but were able to give appropriate interpretations can also be thought of as providing "correct" solutions, and they provide further evidence to support the SS model. Beyond illustrating a few students' attempts to relate their outside-of-school knowledge to the interpretation of a numerical solution to a mathematical problem (e.g., interpreting a fractional remainder as representing a minibus or van), these responses also illustrate a possible limitation of fixed-response formats (such as multiple-choice items) in assuming that only one numerical answer to such problems can be considered correct.

The responses of those students who solved the problem correctly (obtaining an answer of 14) without making any special interpretation of the answer may be seen as providing possible counter-evidence for the SS model. Most of these students did not use long division to solve the problem; rather they used either repeated addition, repeated subtraction, or repeated multiples (basically a "guess and check" strategy). These students executed their mathematical procedure correctly, yet they tended not to map back to the story situation in order to provide an interpretation. It is possible, however, that these responses do not actually refute the SS model, although the responses may require some modification of a few details in the model. It seems reasonable to speculate that these procedures (repeated addition or subtraction), although more mathematically primitive than the long division algorithm, may be more intuitively linked to the situation described in the problem (filling up buses). Consider, for example, that adding up (or subtracting down) more naturally parallels the act of loading individuals on to a bus. Students who used these algorithms, unlike those who used long division, may have used these procedures as a natural consequence of their situation-based reasoning about the problem and may not have felt a need to provide an explanation of their solutions. These more situationally based procedures, unlike the long division algorithm, implicitly contain an interpretative framework.

The only other possible counter-evidence to the SS model was found in the few responses of students who either rounded the numerical answer to get a whole number of buses or estimated the number of buses needed. Although it could be argued that these procedures and interpretations appear to have arisen completely within the mathematical space of the problem and that they are probably not indicative of the students mapping back to the story text or story situation to make sense of the numerical answer, one could also argue that both procedures clearly reflect the situation-based constraint that the only allowable number of buses would be a whole number.

Unsuccessful solution model. Students' responses also provided considerable evidence to support the hypothesized US model. More than 20% of the students, although able to execute correctly an appropriate computational procedure, provided an incorrect numerical answer and offered no interpretation of their solution. Moreover, nearly one quarter of the sample made computational errors that might have been corrected if the students had interpreted their final answers.

Further evidence in support of the US model is provided by the responses of nearly 10% of the students, who solved the problem using long division and made a computational error involving the placement of a decimal point. This error resulted in students obtaining a quotient ten times as large as the actual numerical answer—an error that could likely have been detected if the students had interpreted their answer. Presumably, some students who used an inappropriate computational procedure in their attempted solution might also have detected the error if they had interpreted their solutions.

Influence of Remainder Size

The results of this study provided no indication that remainder size generally appeared to influence the solution processes or interpretations provided by the middle school students in this sample. Nevertheless, students' responses for the problem form in which the remainder was one-half were more likely than responses for the other forms to reveal successful execution of computational procedures and some attempt to interpret the numerical answer. Further research on this issue may be needed, however, since the three problem forms were not equivalent with respect to computational complexity. In order to have a problem form with a remainder of one-half and a divisor of 40, the dividend had necessarily to be a multiple of 10. This unintentional constraint resulted in the problem being an easier computational task than the other forms. Since the students who received this form outperformed the other groups in the correct execution of computational procedures, the computational simplicity may have contributed to the finding that these students also more frequently engaged in interpreting their numerical answers than those students who solved the other forms of the problem. The apparent interaction between computational complexity and situation-based reasoning in this study is reminiscent of one of the major findings reported by Baranes, Perry, and Stigler (1990).

Subject-Area Learning

Edward A. Silver, Lora J. Shapiro, and Adam Deutsch

Additional Observations Regarding Students' Sense Making

Form versus function. Examination of students' responses indicated that many students showed greater concern about the form in which their computations should be executed and in which their final numerical answer should be written than about the relationship between the numerical answer and the problem being solved. For example, many students appeared to be concerned about the form in which the remainder was expressed, such as the sixth-grade student who gave 13 34/40 as her final answer and wrote as her explanation: "I got the answer and I put in [sic] a fraction because that's how our teacher taught us. Should I put the remainder in a fraction?" Students' concern with form was also evidenced in many students' detailed, step-by-step narrative descriptions of the procedures they used to obtain their numerical answers and in some students' comments regarding what they believed to be the correct way to solve the problem (e. g., one seventh grader gave a final numerical answer of 13 and wrote, "I think dividing is the correct way to answer this problem.").

Excessive emphasis on particular calculation procedures or notational forms is likely to impede students from correctly solving an augmented-quotient problem, especially since an interpretation of the numerical response is generally needed. As noted above, except possibly in the case of some alternative algorithms, students generally need to exit from the mathematical space in order to return to the story situation and interpret their numerical answer. To engage in such processing, however, a student must perceive the need to do so. If issues of mathematical formalism are paramount in the students' attention during problem solving, then a strong motivation for interpreting the numerical result is less likely to exist. It is encouraging to note that the older students in the sample, although placing considerable emphasis on matters of mathematical form like their younger counterparts, tended to give more consideration to the interpretation of their numerical results.

The large number of responses focusing on form rather than function might reflect a localized instructional influence, or the findings might suggest that middle school students are generally being taught, either explicitly or implicitly, that accurate computations and correct notational form are the most highly valued aspects of mathematics. Current middle school mathematics instruction is certainly dominated by attention to computational procedures, and this emphasis was reflected in the form-oriented responses of the students in this sample. Although it is somewhat encouraging that some students were able to provide interpretations and explanations that went beyond considerations of form, it is even more discouraging that most students were unable or unwilling to do so.

Impact of task format and administration conditions. The paper-and-pencil, free-response format was intended to capture students' solution processes and their situation-based thinking and reasoning. Although it appeared to function fairly well as a medium for some students to communicate their thinking, it was clear that many students were neither accustomed to nor comfortable with explaining their thinking and reasoning.

Some students voiced objections to having to explain their answers, and these came in one of two forms: (a) objections based on never having been taught how to explain their work and that it was a difficult thing to do, and (b) objections based on the apparent belief that correct computations always produce correct answers, thereby obviating the need for further explanation. Such objections (e.g., "I don't know how to explain anything because there's nothing to explain. It is very hard to do this because our math teacher didn't teach us this.") may indicate a lack of experience in providing written explanations for their mathematical work.

Although the requirement of a written response in the form of an explanation or justification clearly made the task difficult for students, their responses appear to have been influenced by more than just that aspect of the task format. For example, an overwhelming majority of students produced solutions in which the long division algorithm was used; yet there is anecdotal evidence to suggest that alternative algorithms may have been more prevalent than the students' written work revealed. In particular, post hoc discussions with some of the teachers who administered the task revealed that some students did preliminary work on the problem on their desk tops or book covers. According to the teachers, many of the students who did this type of "scratch" work used alternative algorithms that were not transferred onto their papers. Instead, these students turned in to their teachers a final product that showed use of the long division algorithm. Moreover, from those teachers who engaged their classes in a follow-up discussion of the problem, it was learned that students not only employed a range of algorithms to solve the problem but also used grouping and counting techniques and drew pictures. These more mathematically "primitive" techniques, however, were apparently judged by the students to be unsuitable for display in their written responses.[1]

The task format and administration conditions also appeared to influence the tendency of students to provide explanations and interpretations of non–whole-number answers. Anecdotal evidence from our discussions with teachers whose students participated in the study indicated that, during the discussions that followed the problem-solving activity in some classes, many students argued vigorously for alternative solutions using a variety of interpretations for the remainder and explanations of how to represent their interpretation numerically. Some students apparently argued that an extra bus was not needed because some students would be absent and would not attend the game. Others were reported to say that some kids could walk to the baseball game because the school is close to the stadium (the school our students attended is located less than one mile from the baseball stadium mentioned in the problem). These rich, situation-based comments about possible problem solutions are reminiscent of the kinds of reasoning exhibited by some students in the Smith and Silver (1991) interview study, yet they were rarely found in the children's written responses in this study.

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[1] These discussions were held at a summer staff development session that occurred several months after the task administration. Because the school year had ended and students had dispersed for the summer, it was not possible to pursue these issues further in individual student interviews.

Children's perception of this task as a school mathematics problem, rather than a task about which to be thoughtful, may have negatively influenced their performance. The task was administered by their mathematics teacher as part of a regular mathematics class; hence students probably viewed it as a formal classroom exercise and therefore responded in a manner that they believed to be both "mathematically correct" and acceptable to their teacher. The formality of writing a response rather than giving it orally in a class discussion may also have contributed to the tendency of students not to reveal all of their informal thinking and reasoning about the problem. Although the available data make it impossible to be certain of the cause, it seems clear from these anecdotes that task format and administration conditions probably limited the range of students' responses. The written, free-response task format was clearly useful in revealing much about students' solution processes and interpretations, but these anecdotes suggest that the written responses may reflect only a portion of the students' thinking about the problem and that they were capable of more situation-based reasoning than their written responses revealed.

Interesting confirmation for this view comes from the preliminary findings of Curcio and DeFranco (F. Curcio, written communication, 26 January 1991). In their study, 20 middle school students solved two similar versions of the "bus" problem. The first task was presented as one of 21 interview items in which subjects were asked to review the work of another student who had solved a division-with-remainders task similar to the one in this study. The student's long division calculation and an answer in which the remainder was expressed as a fraction were presented, and the subjects were asked to comment on the result and to determine what answer they would give for the problem. On the second task, subjects were presented with a set of facts involving numbers of persons going on a trip and the capacity of commercial vehicles available for transportation. The students were asked to make a telephone call (on a teletrainer) to order transportation for a school trip. Students had far greater success in solving the second task (17 out of 20 correct) than the first task (12 out of 20 correct). On the second task, the students in the Curcio and DeFranco investigation were more likely to apply situation-based reasoning and interpretation. For example, six students ordered a number of vans and then asked for "like a car or something" to take the remaining students. Another student argued that some students would surely be absent, so it would be unnecessary to order an extra van. Although the findings reported by Curcio and DeFranco are intriguing, design limitations in their study prevent a clear determination of whether student responses are due to the effects of problem context or problem order. Nevertheless, the findings generally suggest that the performance context can be a powerful influence on students' problem-solving processes and reasoning.

From the discussion above, it appears that the general performance context in this study, that is, the combination of task format and administration conditions, may have led students to respond in ways that emphasized behaviors they believed to be mathematically relevant, such as the application of formal algorithms, and give little attention to the exhibition of behaviors they believed to be mathematically irrelevant, such as situation-based reasoning and interpretations. Surely, these issues related to the influence of context on performance need to be considered in future assessments of students' problem solving and sense making.

CONCLUSIONS

The findings of this study contribute to our understanding of student performance in solving division-with-remainder problems and contribute more generally to our understanding of the relationship between situation-based sense making and mathematical problem solving. Semantic-processing models, incorporating Kintsch's (1986) important distinction between story text and story situation, were proposed to explain students' success or failure in solving division-with-remainder story problems on the basis of the presence or absence of an adequate interpretation after the solver obtains a numerical solution. The results obtained from the paper-and-pencil instrument administered in this study confirmed that the models provide a solid explanation of students' oft-reported failure to solve such problems in school settings, especially for students using the long division computational procedure. In fact, it is likely that the models could be extended to explain students' success or failure in the solution of multistep story problems in which the result of one calculation step must be interpreted prior to the execution of a second calculation step. Multistep problems are notoriously difficult for students, and a simple extension of the US model proposed in this study may provide a semantic-processing explanation for the difficulty that goes beyond other explanations based primarily on the syntactic features of such problems (Goldin & McClintock, 1979).

Although the findings of this investigation demonstrate the power of the proposed models in identifying a semantic-processing deficiency associated with unsuccessful solution, the findings also illustrate the limitations of the models in accounting for two important mediational factors: the school performance context and the difficulty of providing a written explanation. The anecdotal reports of students engaging in more situation-based reasoning than was evident in their written responses suggest that students' failure to provide an appropriate interpretation may be due, at least in part, to their dissociation of school mathematics performance from more natural ways of thinking and reasoning about the world. Viewed from this perspective, it is clear that a general model to explain students' successful or unsuccessful solution of such problems would need to consider the performance context and its associated constraints.

The suggestion that student performance may have been adversely affected by the dissociation of sense making from the solution of school mathematics problems points to the need for more instructional attention to sense making as a part of school mathematics instruction. Yet, even if mathematics instruction were to make stronger connections between school mathematics problems and procedures and the forms of thinking and reasoning prevalent in out-of-school situations, the results of this investigation suggest that other issues must also be addressed in order to improve student performance.

As noted above, students had great difficulty in providing written explanations of their reasoning. Some students may have been more capable of explaining their thinking and reasoning orally than they were able to do in writing, and this points to the need for written explanations to become a more prevalent feature of school mathematics instruction. Assignments requiring students to provide explanations for their work are consistent with calls for greater emphasis on communication in the mathematics classroom (NCTM, 1989; Silver, Kilpatrick, & Schlesinger, 1990). The results of this study suggest that, unless and until solution explanations and interpretations become a regular item on the menu of instructional activities in mathematics classrooms, it is unlikely that many students will spontaneously engage in such activity when it is appropriate to do so. Moreover, until students are more accustomed to explaining their mathematical thinking and reasoning in writing, researchers will be stymied in their efforts to gather, in an efficient manner on a large scale, rich descriptive data about student thinking.

Since the task used in this study may have appeared to students as being primarily about solving a problem rather than interpreting a solution, a potentially fruitful area for further investigation involves the examination of alternative assessment settings or formats that might target more directly the need for sense making and solution interpretation. For example, the type of written task used by Curcio and DeFranco, in which students were asked to examine the work of another student and determine or critique a proposed answer, might be used to stimulate students' situation-based reasoning, because the computational burdens would be removed and the goal-directedness toward problem solution might be reduced in favor of interpretation and sense making.

The findings regarding students' use of alternative algorithms and the likely connection between these alternative procedures and situation-based reasoning about the problem suggests another interesting area for future investigation. In their study of problem solving across different contexts, Baranes et al. (1990) reported an apparent relationship between students' use of solution strategies and certain contextual features of the problem situation. Although limited in scope, the findings of Baranes et al., taken together with the results of the study reported here, suggest the potential value of examining more closely the relationship between problem-solving procedures and situational contexts.

In addition to extensions of the proposed semantic-processing models to incorporate important mediational factors influencing students' likelihood of engaging in solution interpretation, and in addition to continued research related to the general issue of understanding how and when students connect mathematics to situations, the findings of this study suggest the wisdom of developing and implementing instructional activities in which children are challenged to engage in mathematical sense making. Clearly, this study has shown that American students in the middle grades need much more experience in explaining their solutions to mathematical problems. If students continue to dissociate thoughtfulness from the solution of problems, there can be little hope of substantially improving the poor mathematics performance of American students.

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